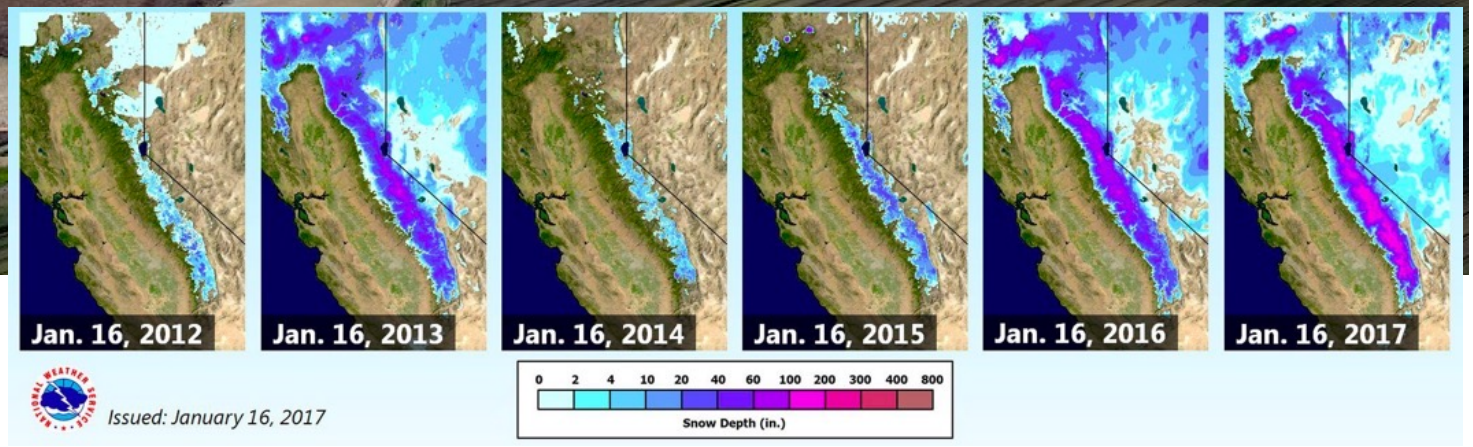
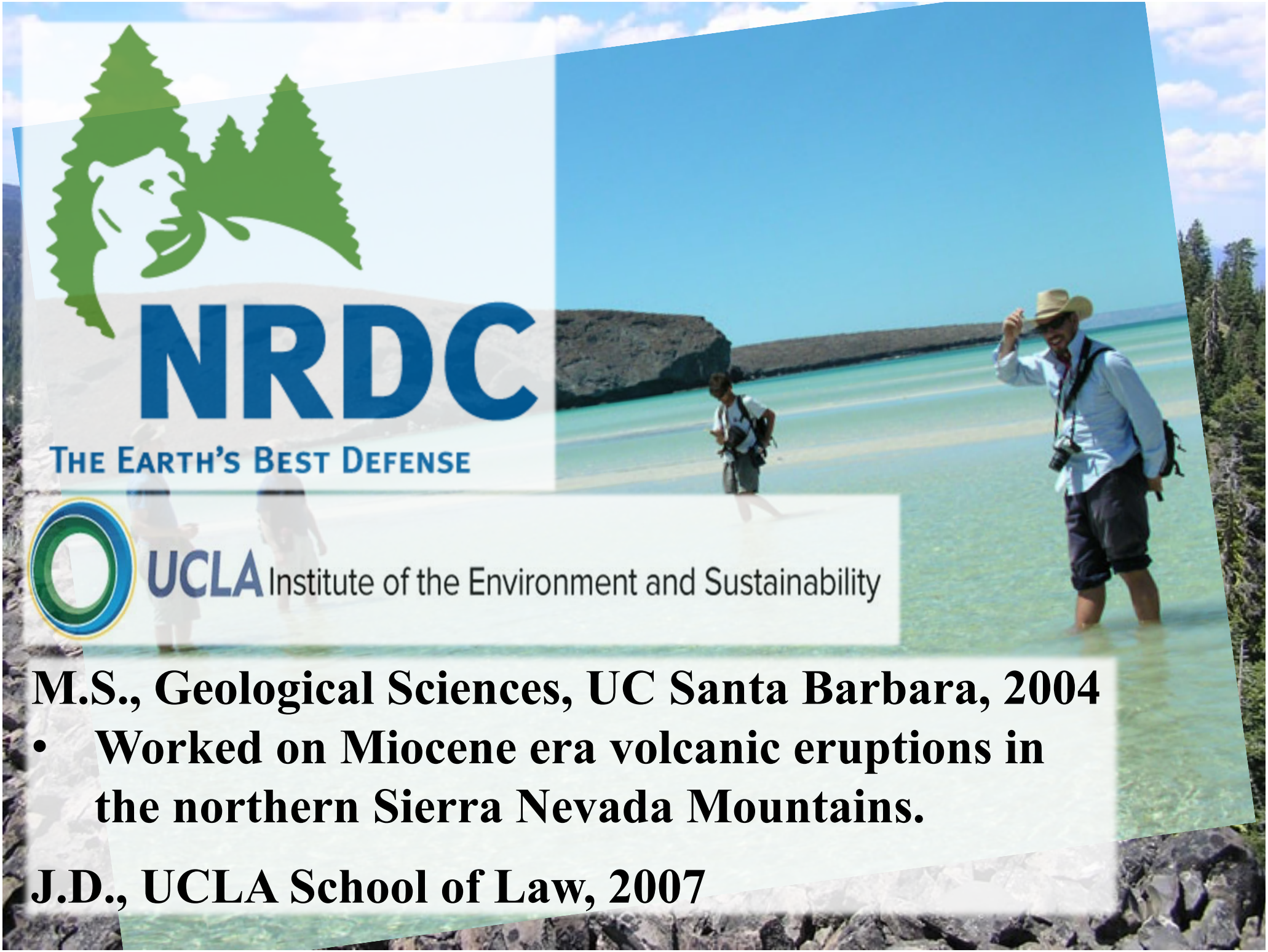
Leadership in Water Management



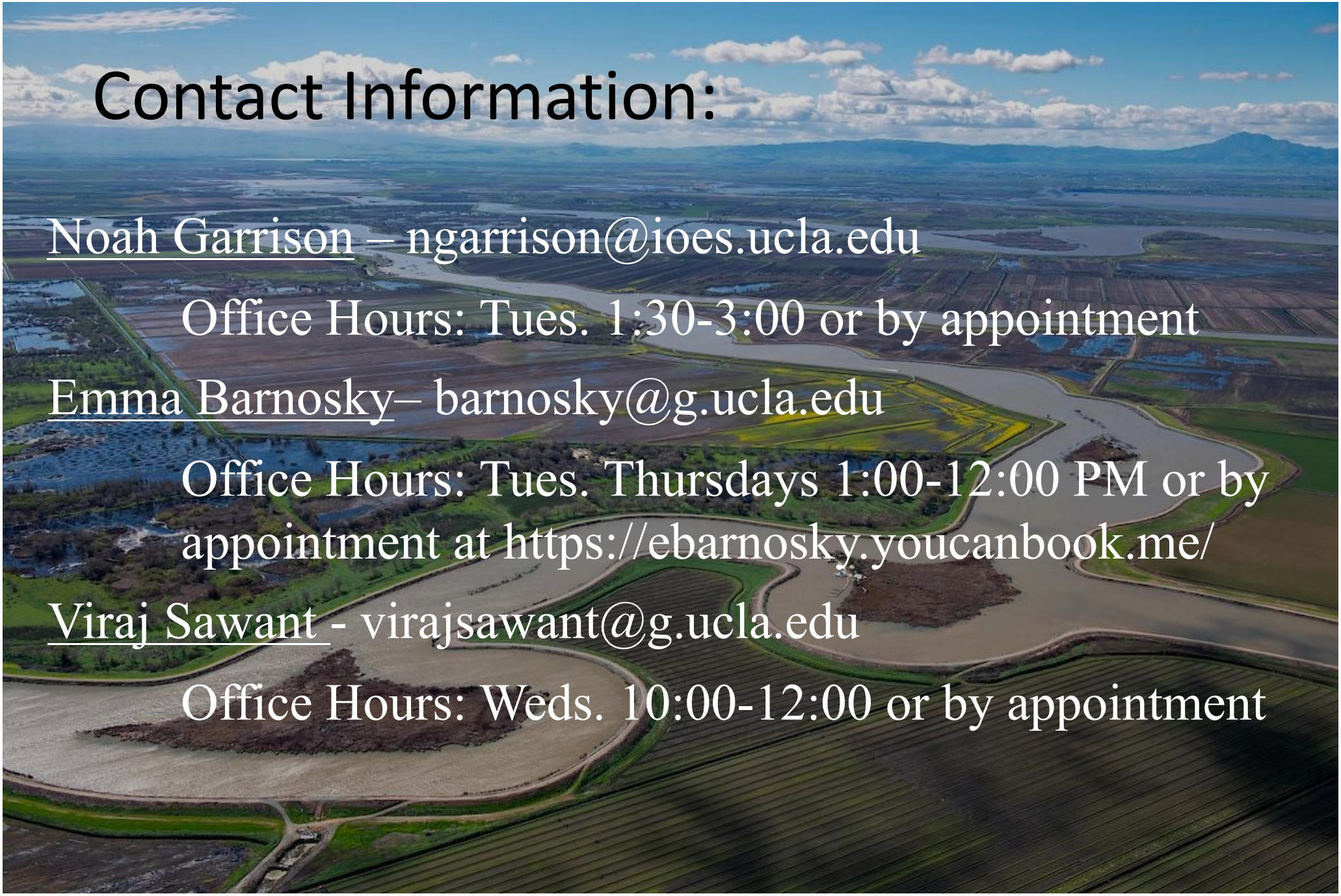
Introductions



M.S., Geological Sciences, UC Santa Barbara, 2004

- **Worked on Miocene era volcanic eruptions in the northern Sierra Nevada Mountains.**

J.D., UCLA School of Law, 2007



Contact Information:

Noah Garrison – ngarrison@ioes.ucla.edu

Office Hours: Tues. 1:30-3:00 or by appointment

Emma Barnosky– barnosky@g.ucla.edu

Office Hours: Tues. Thursdays 1:00-12:00 PM or by appointment at https://ebarnosky.youcanbook.me/

Viraj Sawant - virajsawant@g.ucla.edu

Office Hours: Weds. 10:00-12:00 or by appointment

Grading:

- Two quizzes (10% each) given during the discussion section of weeks 3 and 5
- Two short assignments (10% each):
  - Memo: a 3-page, *collaborative*, objective report/memo on an issue you select from a list provided by the Instructor and TAs,

    AND
  - Testimony: *Individual* delivery of verbal testimony advocating for a course of action to be taken by a public agency to address the same issue
- A final group project (25%) and presentation (10%)
- Class participation (25%)

Each of you will also complete a peer review of your teammates for your work on your group projects.

Class participation will be evaluated through factors including asking questions, completing makeup summary assignments, answering questions on the readings when "on-call," and leading a guided discussion during weekly sections.

Class can be attended in person or watched live via livestream, or can be watched in a recorded session (with makeup assignments) – *no one will be penalized for viewing the livestream or recorded versions*.

Absent prior approval for extenuating circumstances, late assignments will be awarded:

- 90% credit if turned in by 10:00AM the next morning
- 80% if turned in the following day by 5:00PM, and
- 50% if turned in by the next discussion section the following week.

Without prior approval, assignments that are more than 7 days late will not be accepted.

For students watching a recorded lecture or discussion section:

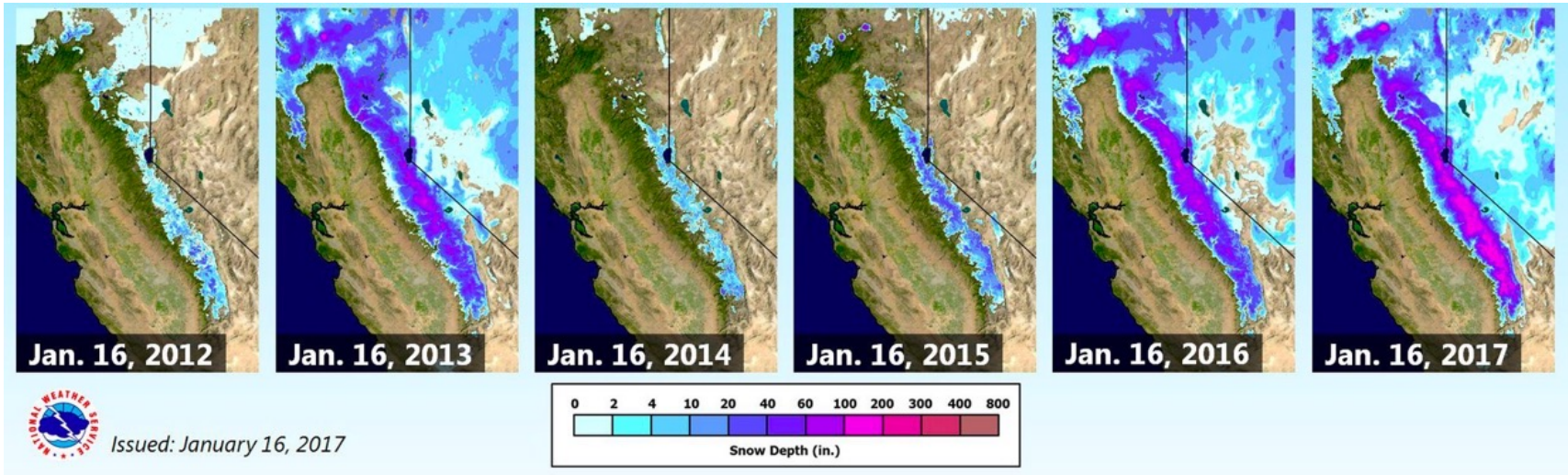
- Submit a 1-page (double-spaced) summary of some aspect of the lectures, what you found interesting about them, and how they relate to broader environmental issues.

For any discussion section missed, you may either:

- **At least one hour before the start of your section,** submit a question regarding some aspect of the week's lectures for the TA through the class CCLE page discussion forum thread for that week AND note, in a response to your comment, if (or how!) the TA raised your comment in discussion.
- By Sunday night of that week submit a 1-page, double spaced summary or analysis of an interesting news article or blog posting on a current water topic from the past two weeks. Possible sources are listed in the syllabus.

Topics for short assignments and for final group projects will be posted after class on Tuesday, Sept. 28.

- Select groups for final project by Friday, Oct. 8, 5:00 PM
- Topic selections for group projects due by the start of class in Week 3 – Thursday, Oct. 14.
- Select partner and topic for objective memo no later than 12:00 pm (noon) Friday, Oct. 15.



Class COVID Policy

(see the syllabus…)

Be kind

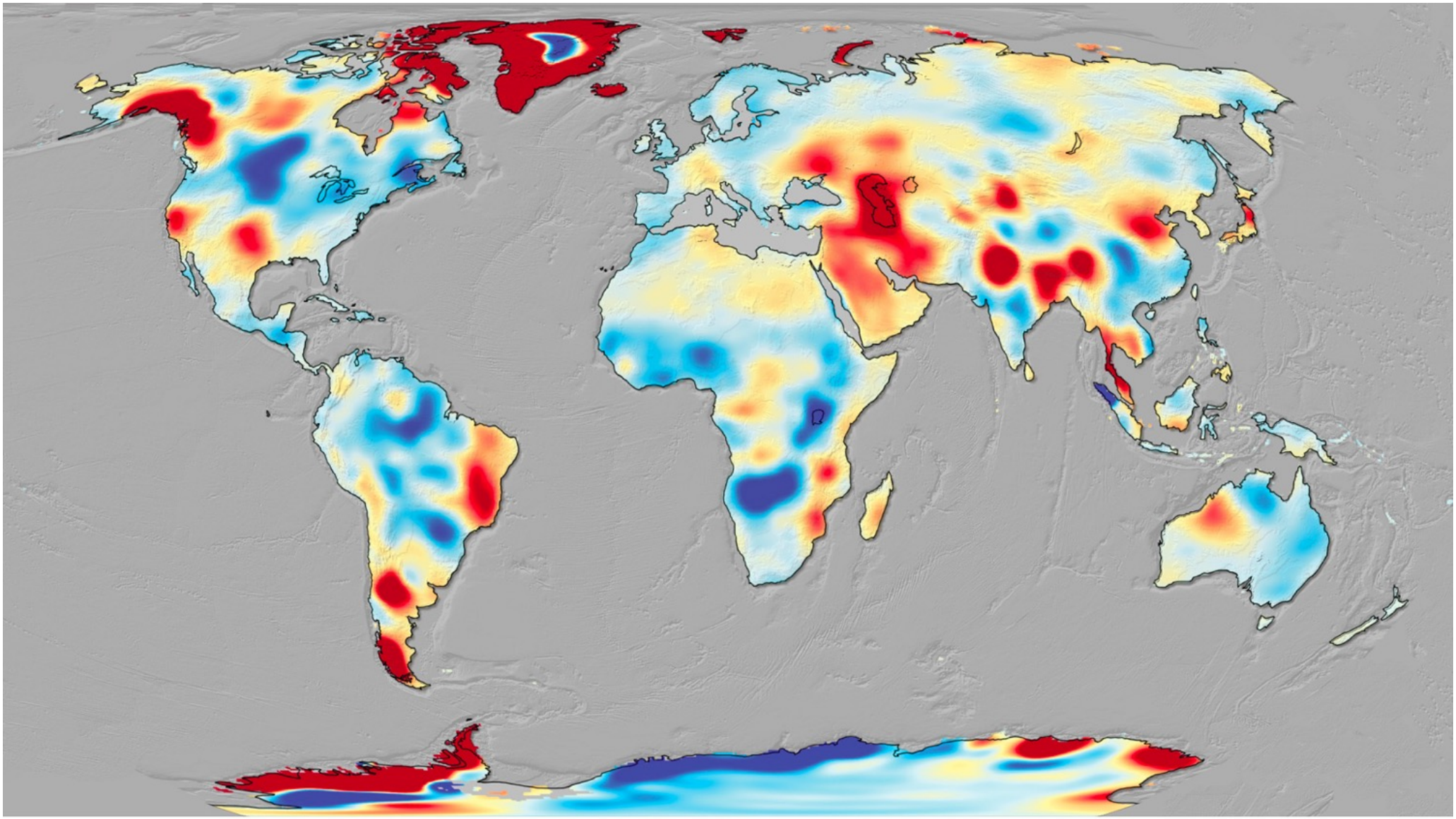
Be Patient

Be Safe

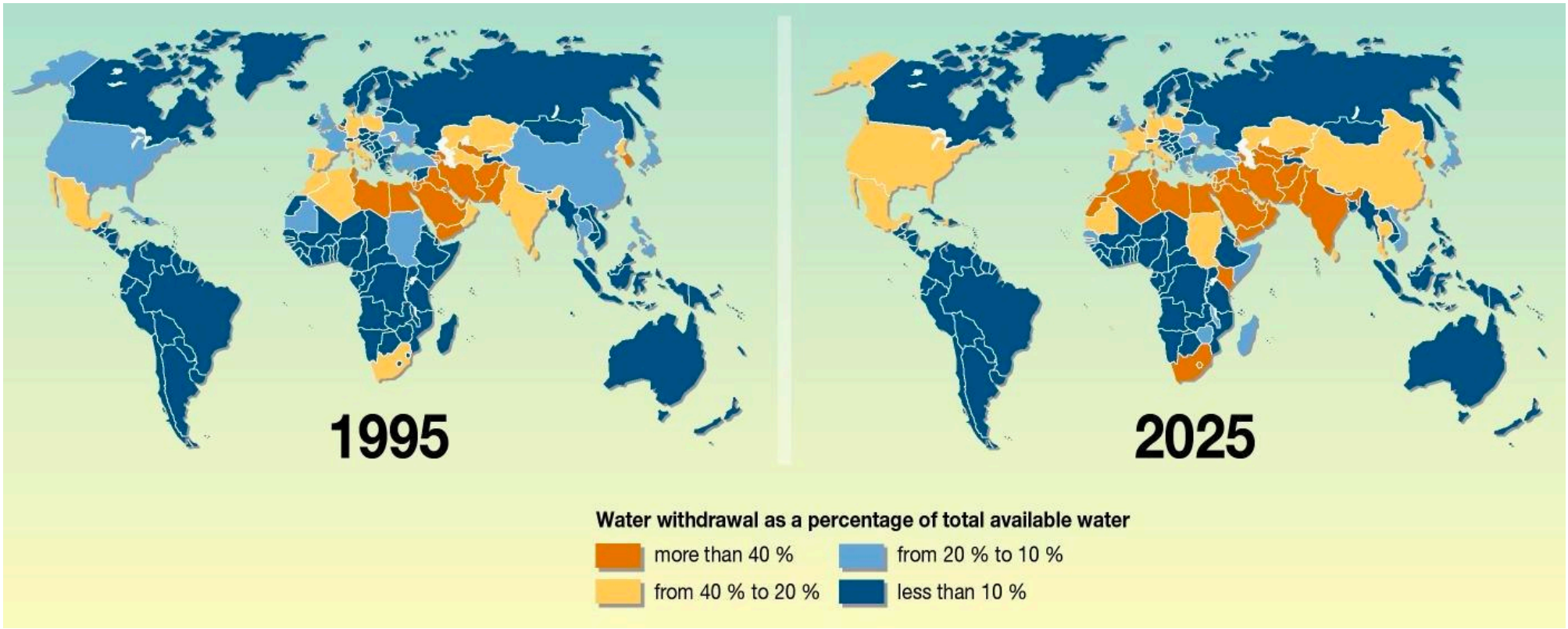
STAY HOME

Rest

Get Better



(2002-2016)
NASA, GRACE, 2018.


1995
2025
Water withdrawal as a percentage of total available water
more than 40 %
from 40 % to 20 %
from 20 % to 10 %
less than 10 %

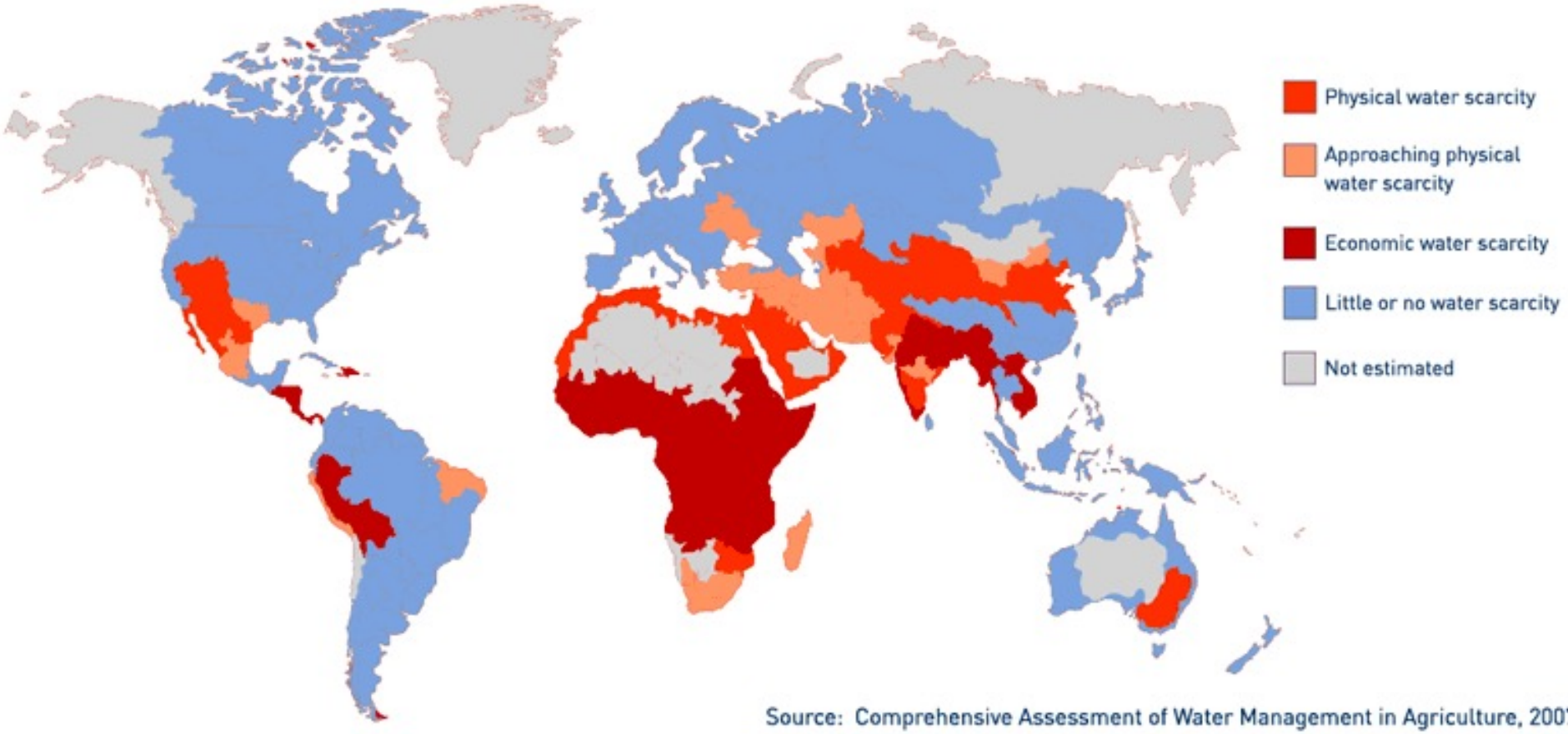
AREAS OF PHYSICAL AND ECONOMIC WATER SCARCITY

Physical water scarcity water resources development is approaching or has exceeded sustainable limits). More than 75% of the river flows are withdrawn for agriculture, industry, and domestic purposes (accounting for recycling of return flows). This definition—relating water availability to water demand—implies that dry areas are not necessarily water scarce.

Approaching physical water scarcity. More than 60% of river flows are withdrawn. These basins will experience physical water scarcity in the near future.

Economic water scarcity (human, institutional, and financial capital limit access to water even though water in nature is available locally to meet human demands). Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes, but malnutrition exists.

Little or no water scarcity. Abundant water resources relative to use, with less than 25% of water from rivers withdrawn for human purposes.

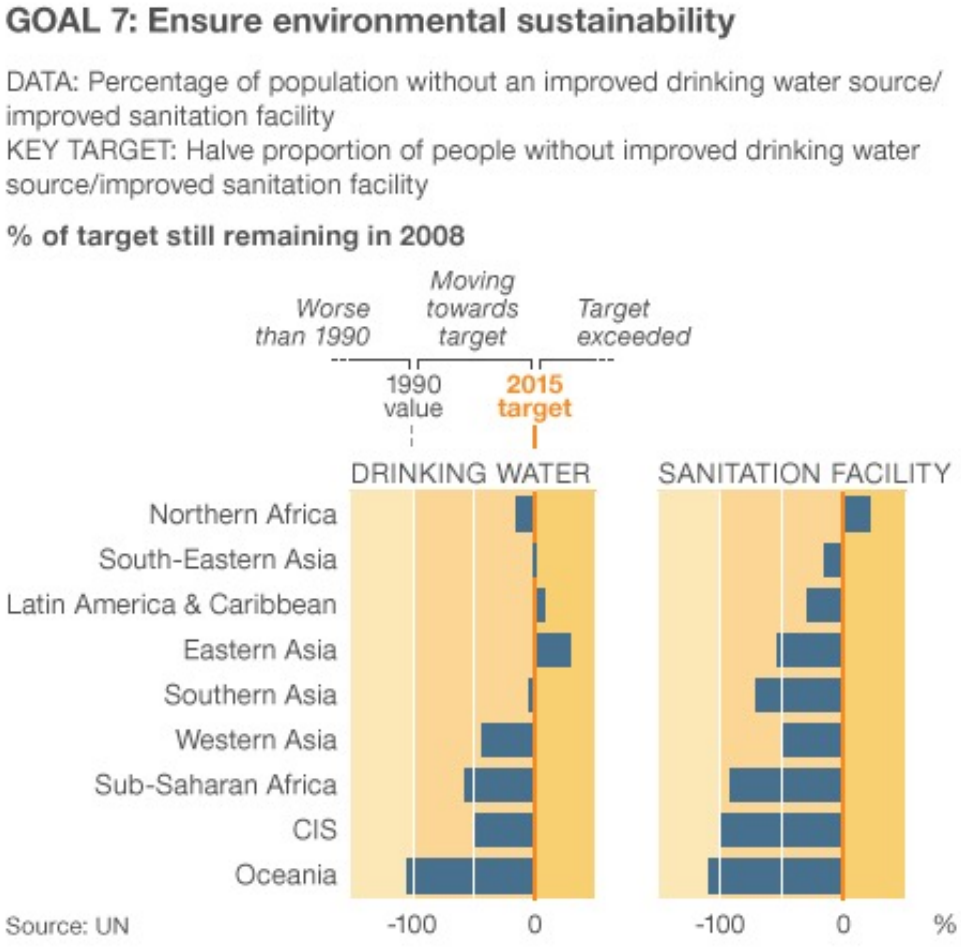


Source: Comprehensive Assessment of Water Management in Agriculture, 2007

2000 UN Millenium Development Goals for Water

Target 7.C:

Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation



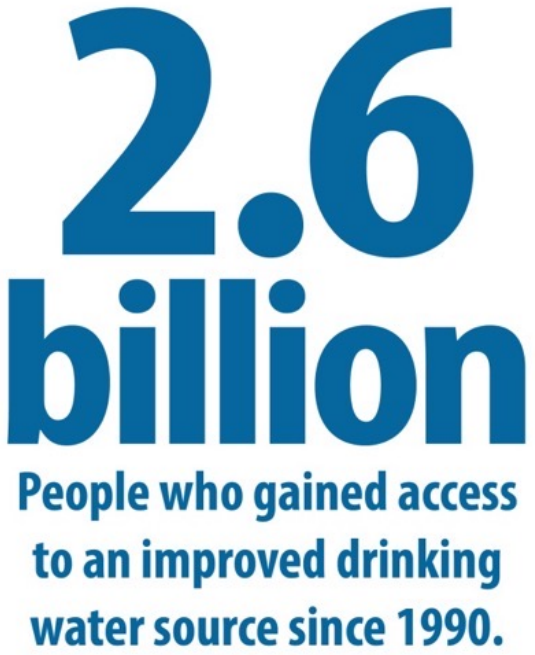
Meeting the MDGs

- In 2015 – approximately 750 million people do not have access to improved water sources.
- 2.5 Billion lack access to improved sanitation
- As a result – approximately 840K people a year die of water borne illness

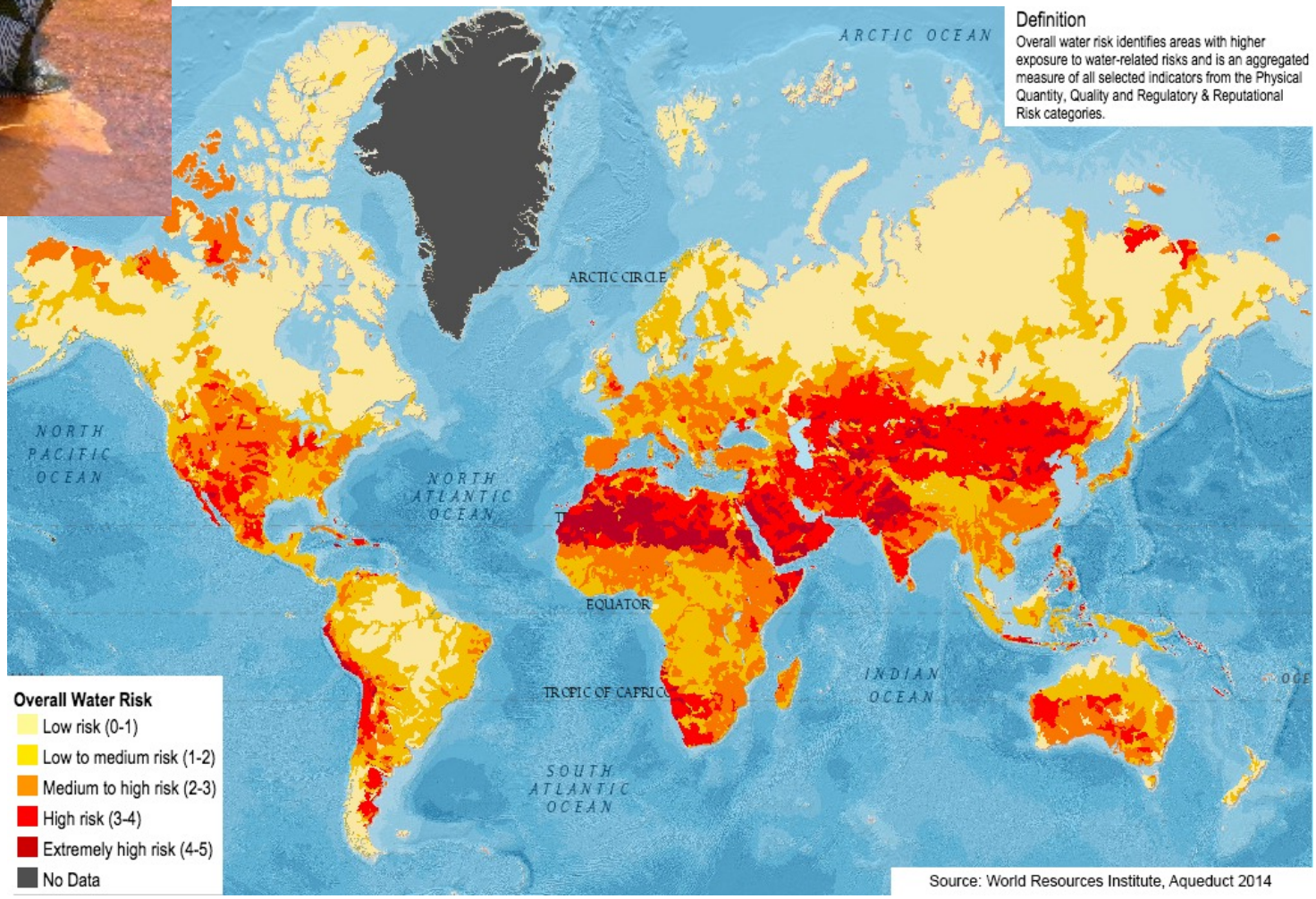
Meeting the MDGs

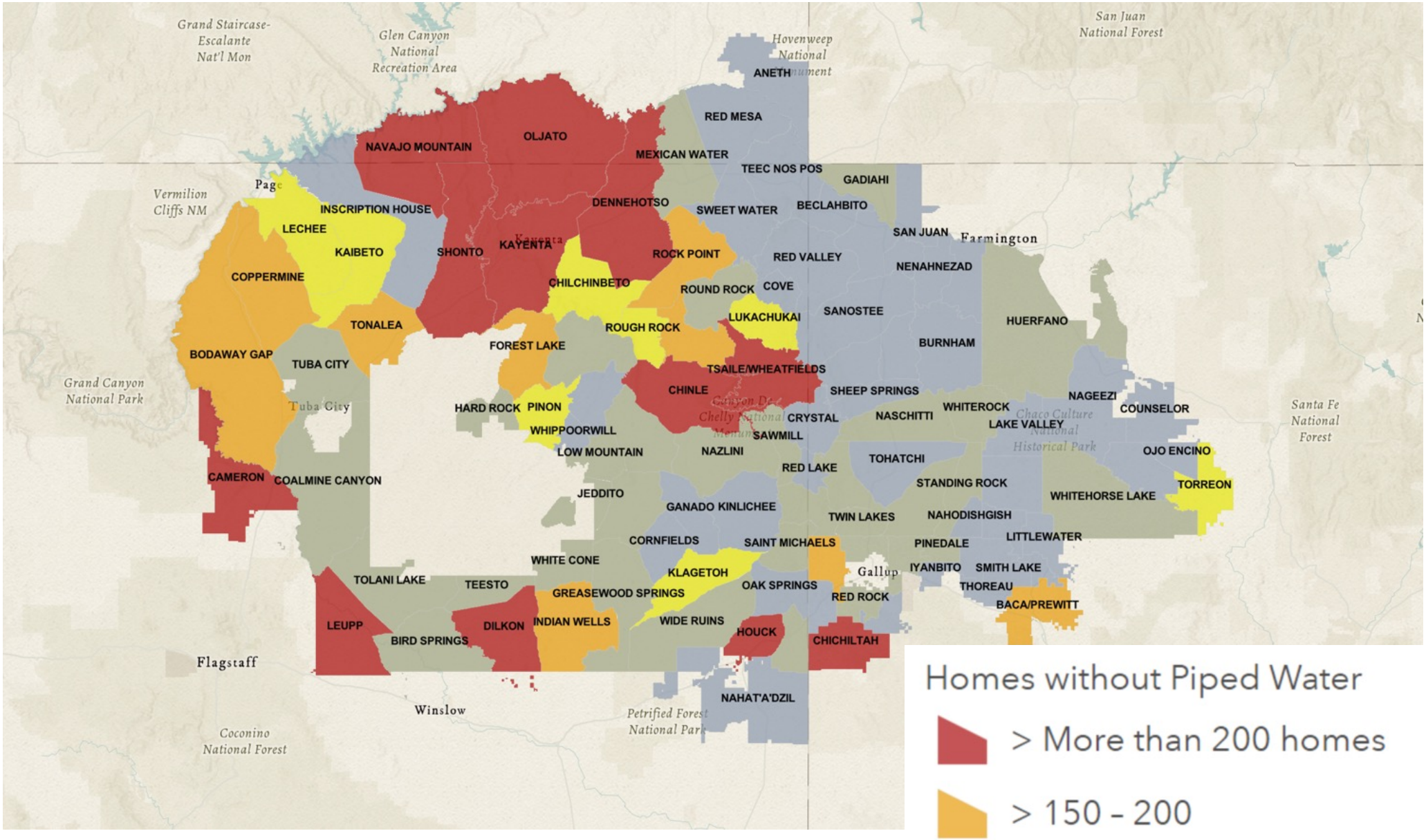
- The world halved the proportion of people without access to improved sources of water by 2010, five years ahead of target.

- Worldwide, 2.1 billion people have gained access to improved sanitation. Despite progress, 2.4 billion are still using unimproved sanitation facilities, including 946 million people who are still practicing open defecation.



Global Water Stress

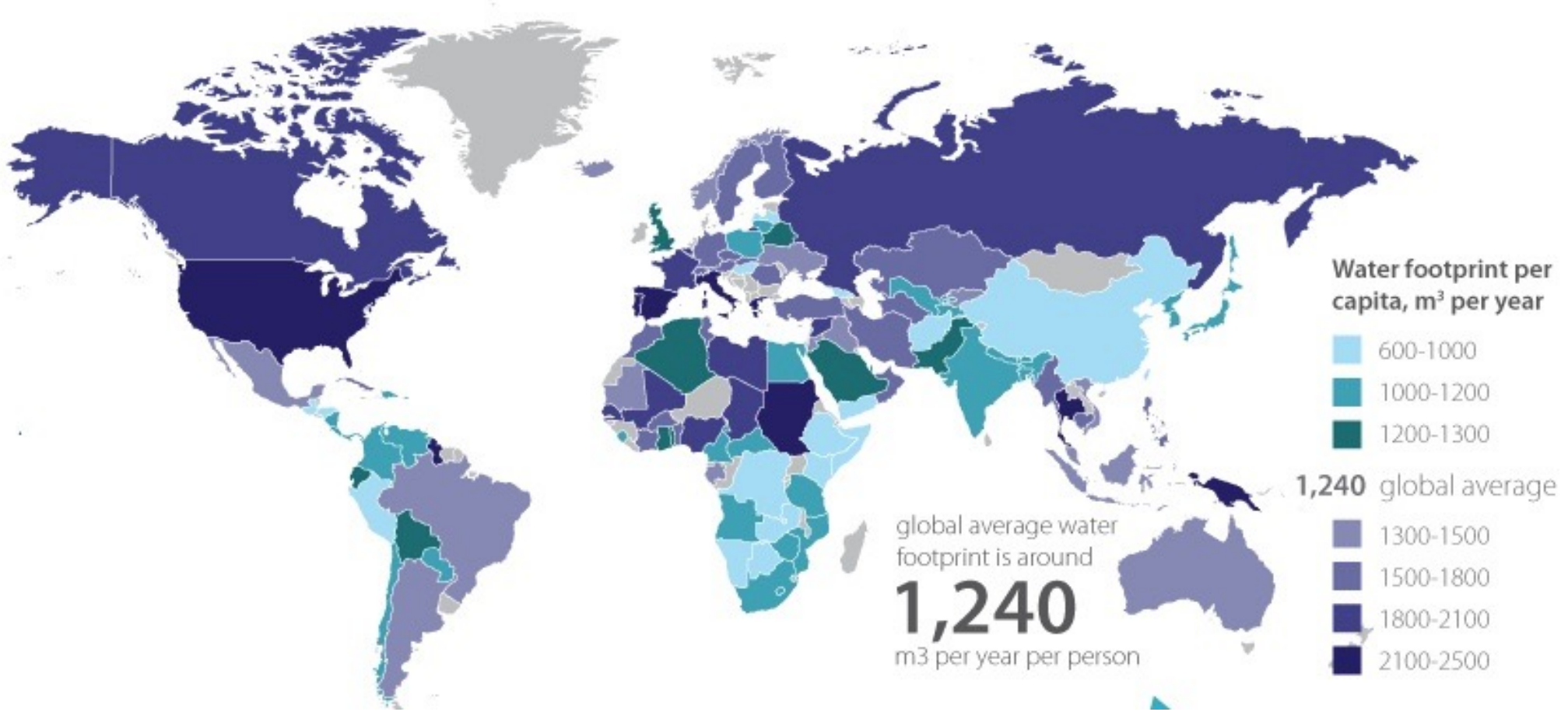

Definition
Overall water risk identifies areas with higher exposure to water-related risks and is an aggregated measure of all selected indicators from the Physical Quantity, Quality and Regulatory & Reputational Risk categories.
ARCTIC OCEAN
ARCTIC CIRCLE
NORTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
EQUATOR
TROPIC OF CAPRICO
INDIAN OCEAN
SOUTH ATLANTIC OCEAN
Overall Water Risk
Low risk (0-1)
Low to medium risk (1-2)
Medium to high risk (2-3)
High risk (3-4)
Extremely high risk (4-5)
No Data
Source: World Resources Institute, Aqueduct 2014

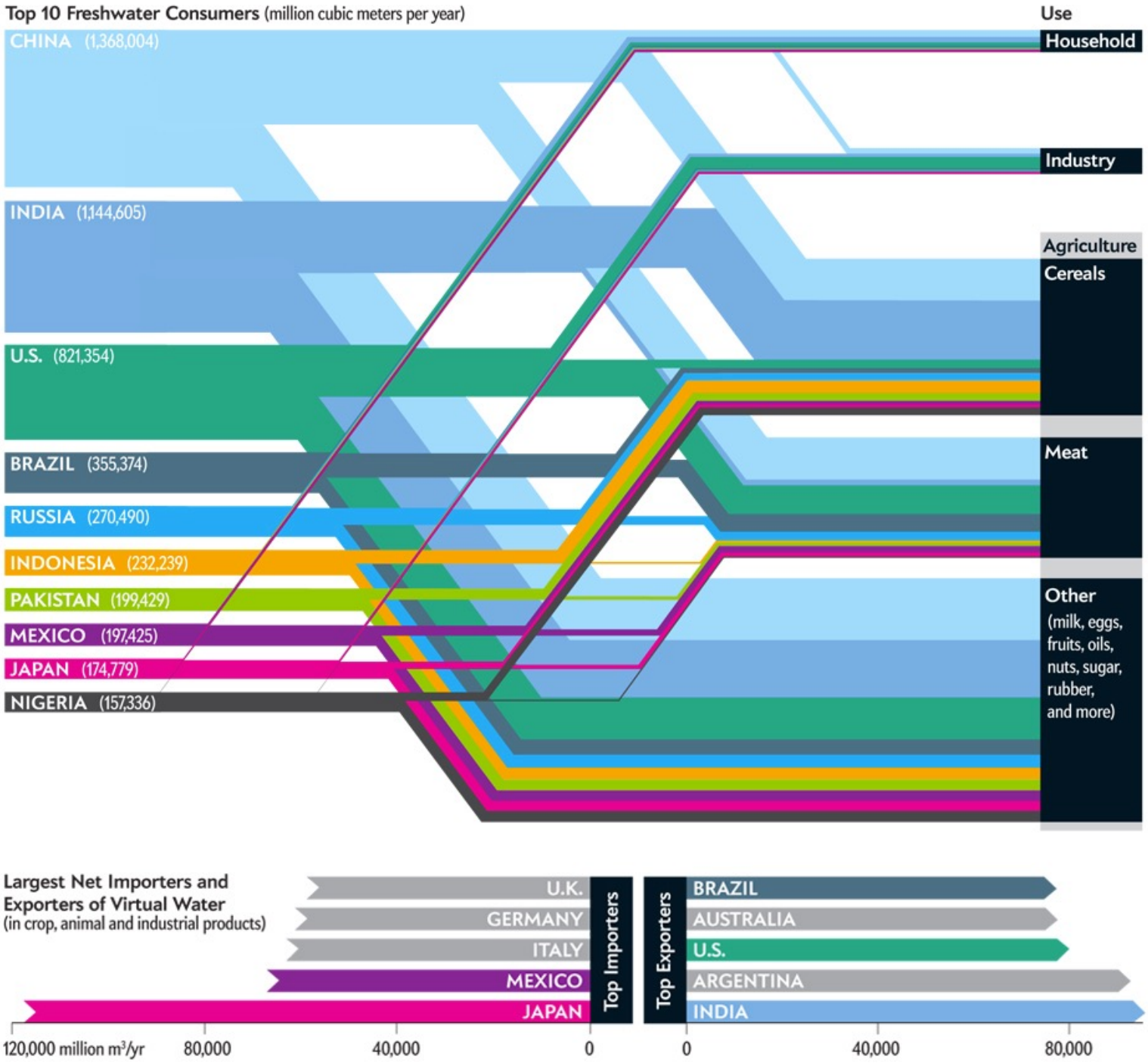


Navajo Nation Water Insecurity

Navajo Safe Water: http://www.navajosafewater.org

Average per capita water footprint by country





Graphics by Jen Christiansen
Source: "The Water Footprint of Humanity," by Arjen Y. Hoekstra and Mesfin M. Mekonnen, in Proceedings of the National Academy of Sciences USA. Published online February 13, 2012

2015 UN Sustainable Development Goals for Water

Goal 3 Ensure healthy lives and promote well-being for all at all ages

3.3: by 2030 end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases

3.9: by 2030 substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination

http://www.unwater.org/fileadmin/user_upload/unwater_new/docs/UN-Water_paper_on_a_Post-2015_Global_Goal_for_Water.pdf

http://www.unwater.org/sdgs/en

UN Sustainable Development Goals

continued

Goal 6. Ensure availability and sustainable management of water and sanitation for all

6.1 by 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.2 by 2030, achieve access to adequate and equitable sanitation and hygiene for all, and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

6.3 by 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and increasing recycling and safe reuse by x% globally

6.4 by 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity, and substantially reduce the number of people suffering from water scarcity

UN Sustainable Development Goals

continued

6.5 by 2030 implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.6 by 2020 protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

6.a by 2030, expand international cooperation and capacity-building support to developing countries in water and sanitation related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.b support and strengthen the participation of local communities for improving water and sanitation management

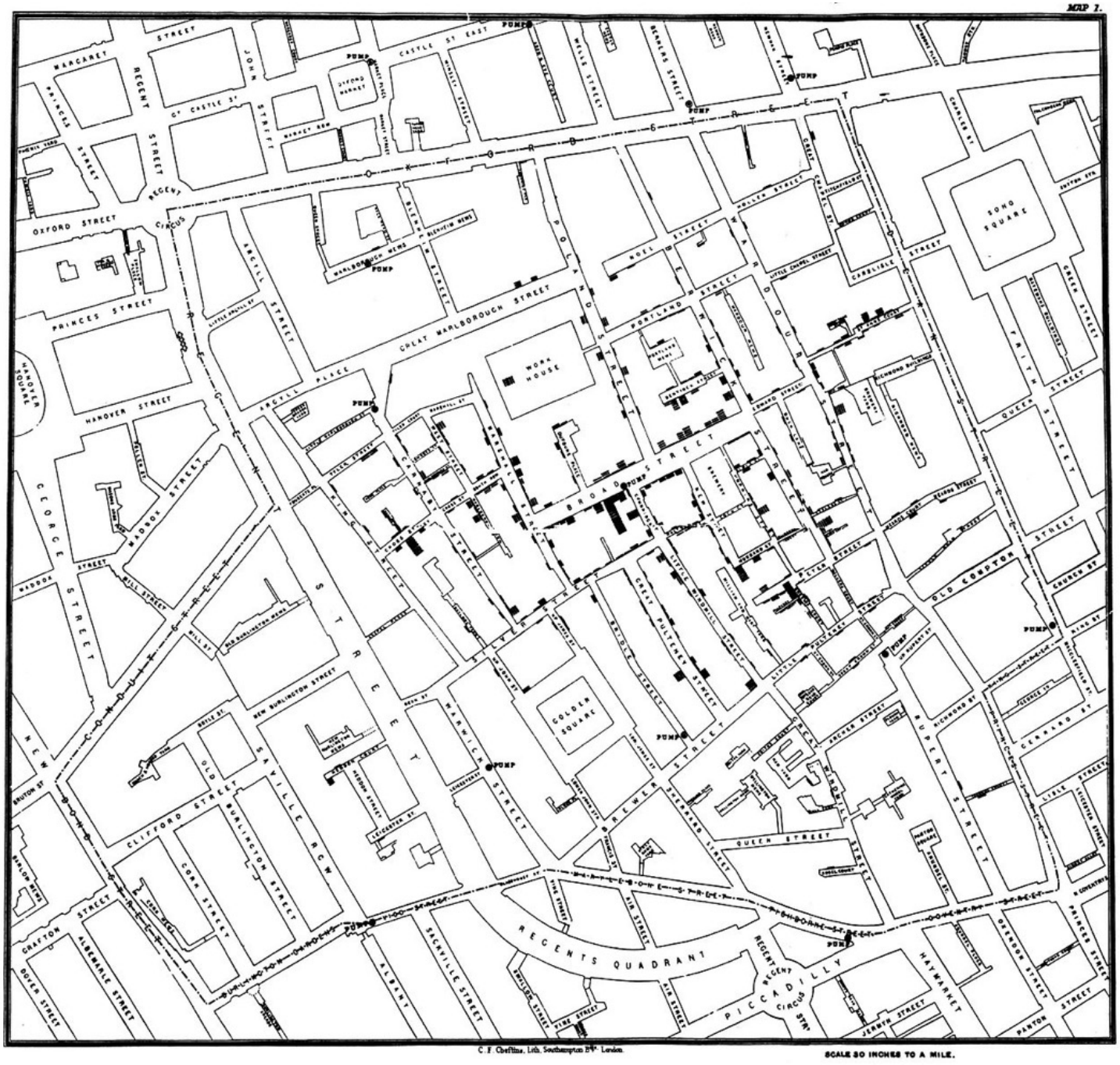
UN Sustainable Development Goals *continued*

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable – 11.5 by 2030 significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations.

Goal 12. Ensure sustainable consumption and production patterns – 12.4 by 2020 achieve environmentally sound management of chemicals and all wastes throughout their life cycle in accordance with agreed international frameworks and significantly reduce their release to air, water and soil to minimize their adverse impacts on human health and the environment.

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss – 15.1 by 2020 ensure conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands, in line with obligations under international agreements.

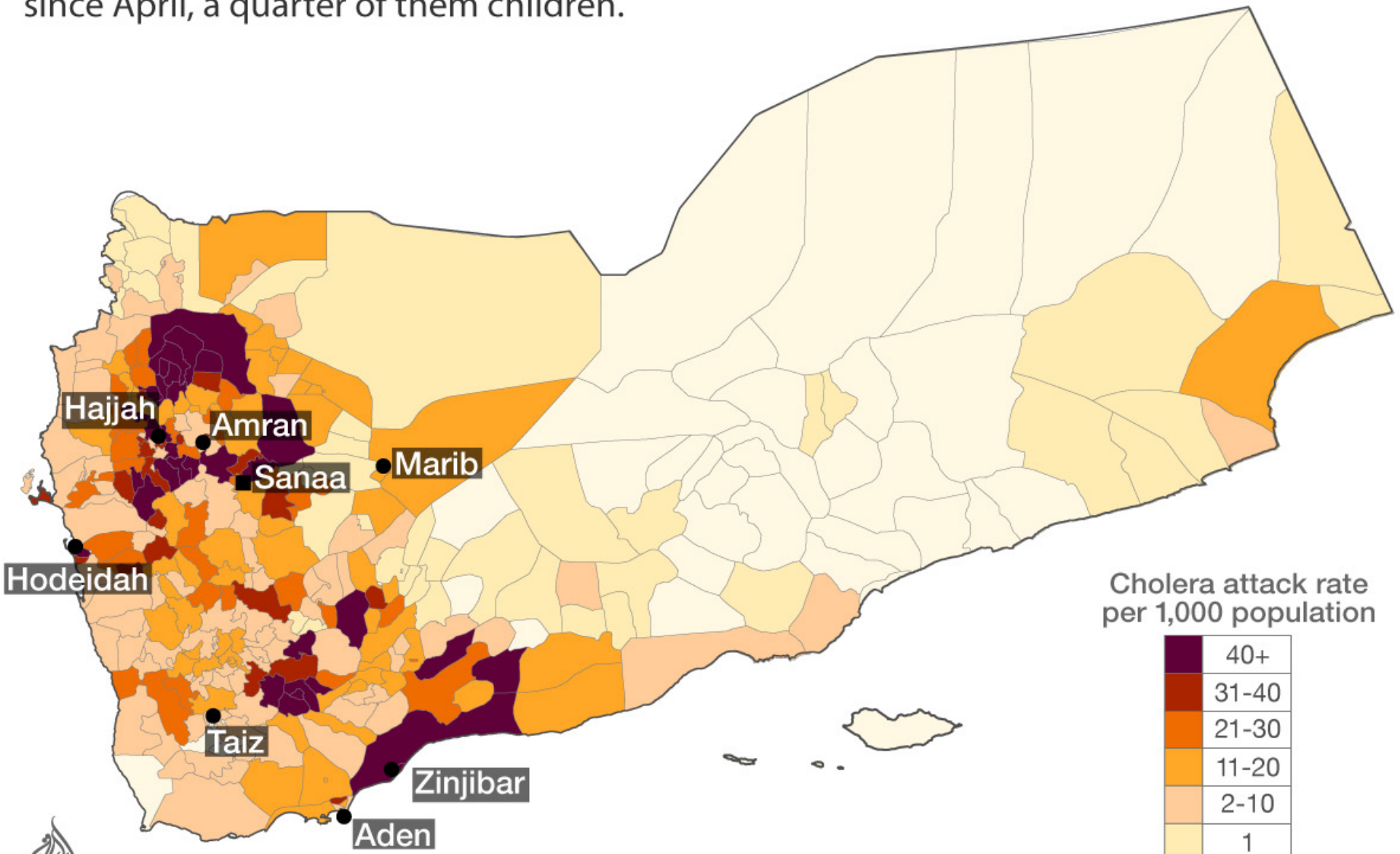
John Snow: Cholera map – 1854



2010 - Haiti Cholera epidemic: over 9,000 deaths and 750,000 cases

Cholera outbreak in Yemen

The "worst cholera outbreak in the world" has claimed more than 2,000 lives since April, a quarter of them children.

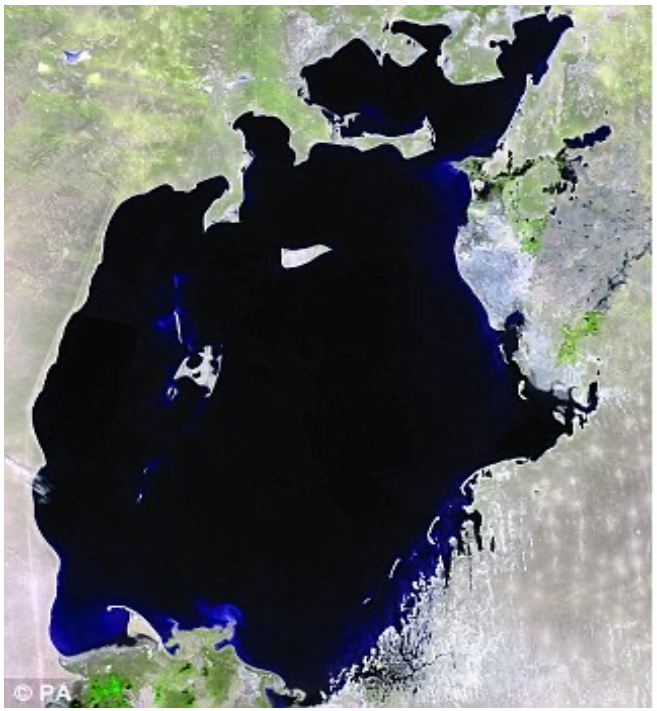


ALJAZEERA

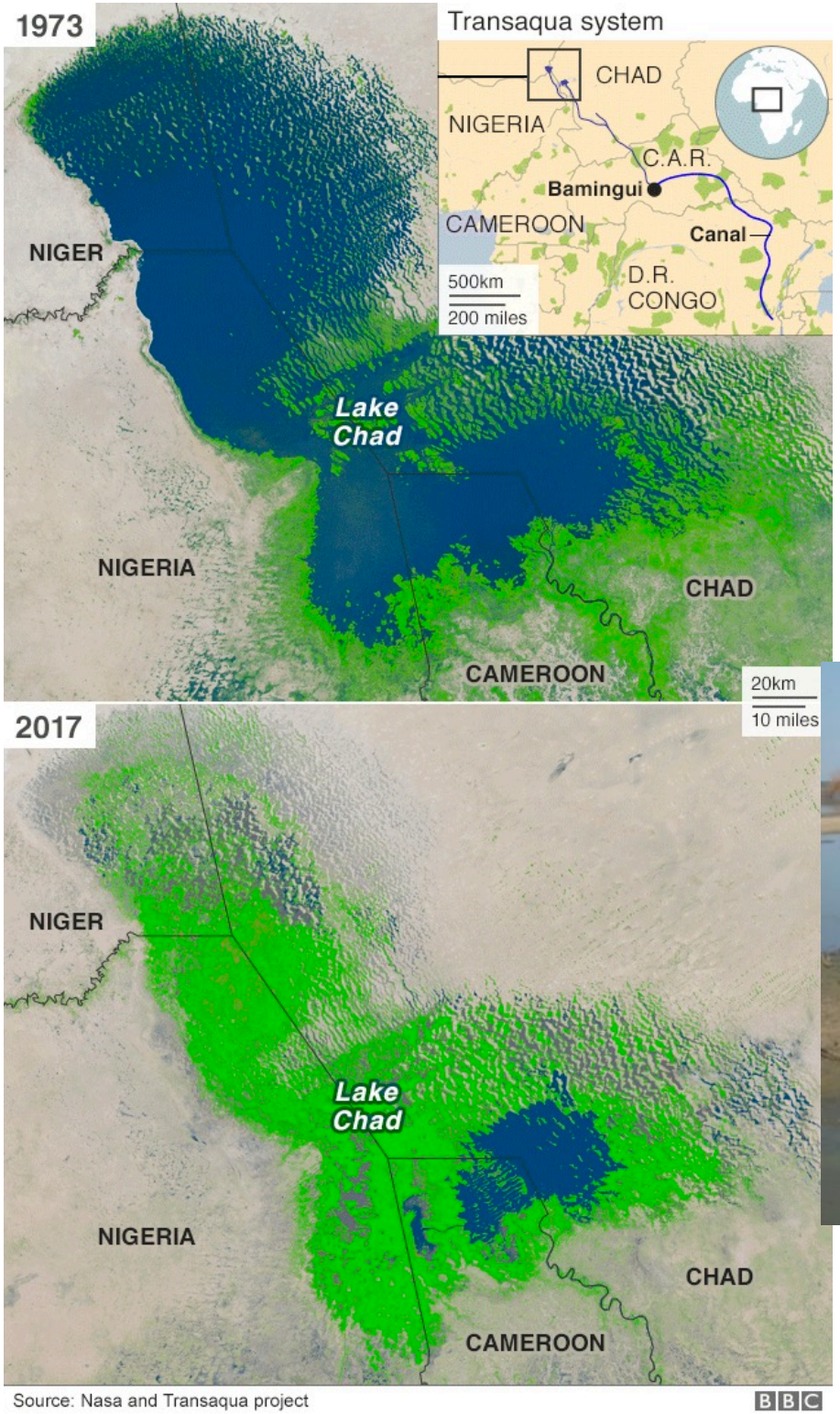
CC BY NC SA

Source: World Health Organization | Last updated: Aug 27, 2017

Aral Sea – Uzbekistan and Kazakhstan

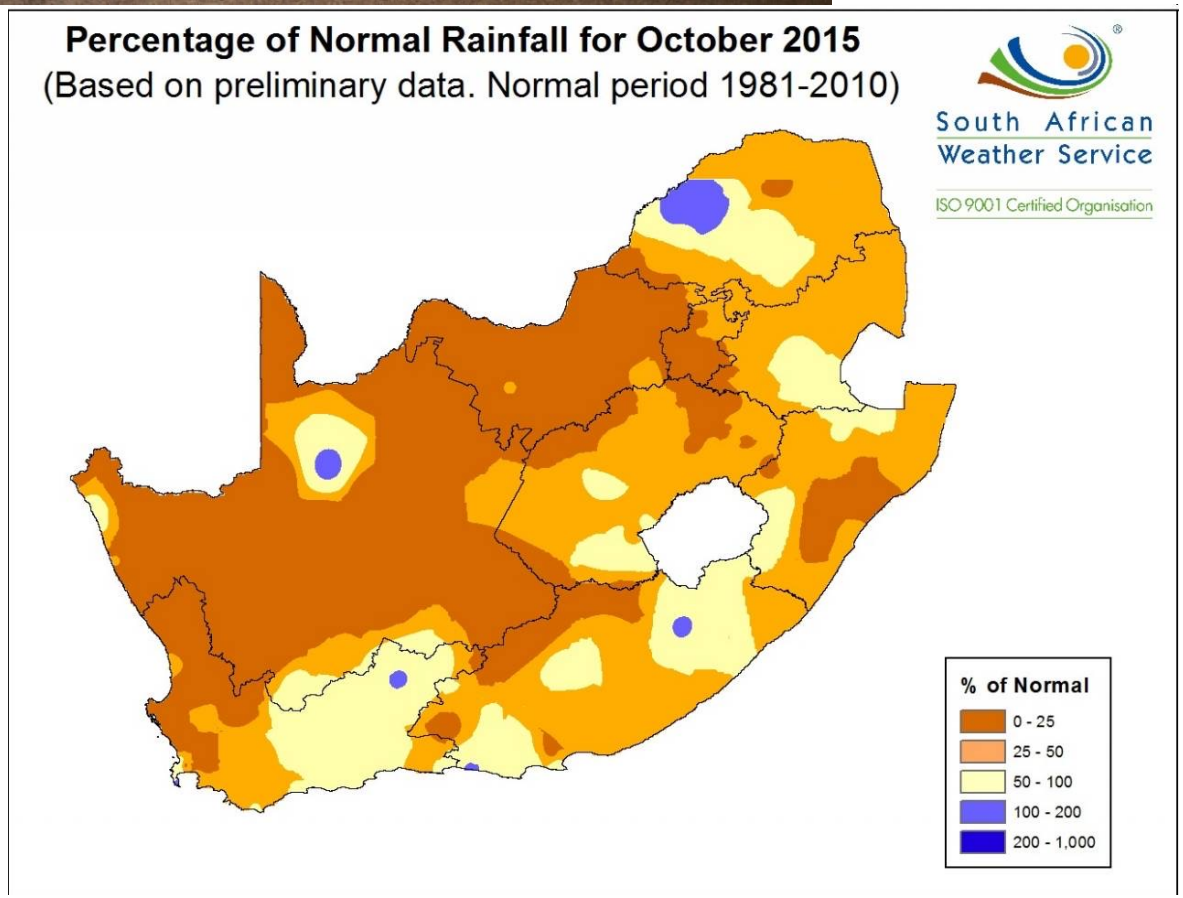


Lake Chad

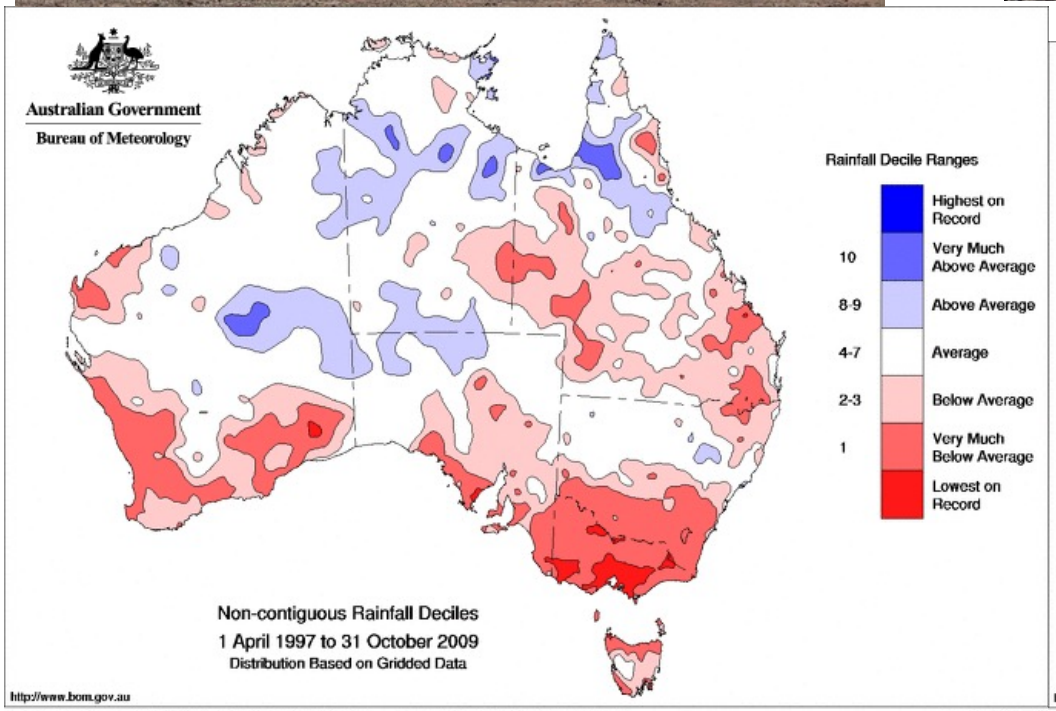

1973
Transaqua system
CHAD
NIGERIA
C.A.R.
Bamingui
CAMEROON
Canal
D.R.
CONGO
500km
200 miles
NIGER
Lake
Chad
NIGERIA
CHAD
CAMEROON
20km
10 miles
2017
NIGER
Lake
Chad
NIGERIA
CHAD
CAMEROON
Source: Nasa and Transaqua project
BBC

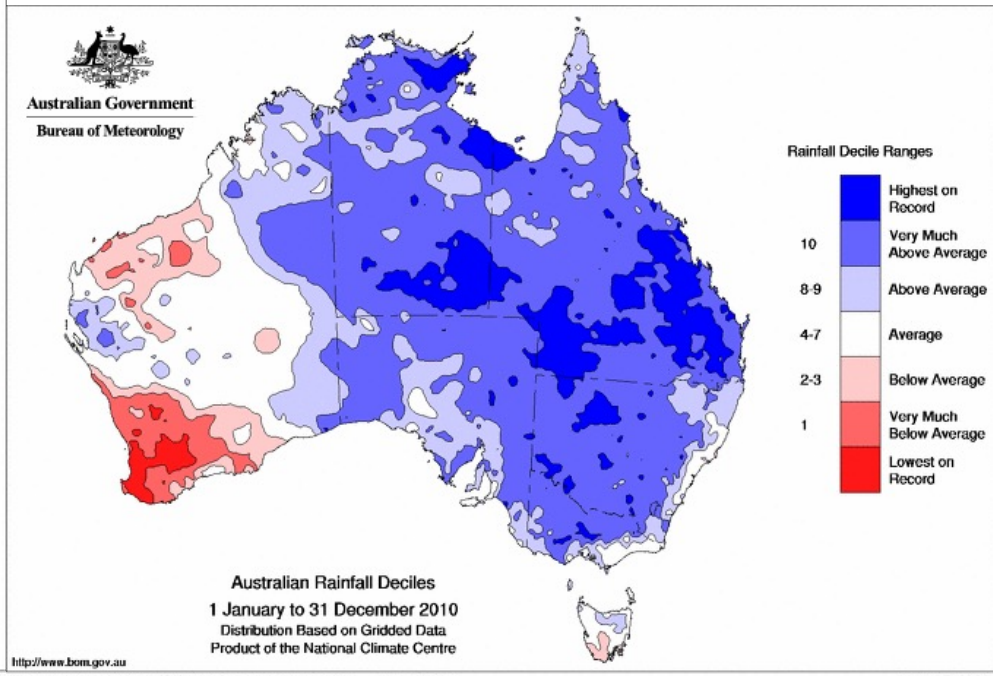
unicef

South Africa Drought


Percentage of Normal Rainfall for October 2015
(Based on preliminary data. Normal period 1981-2010)
South African Weather Service
ISO 9001 Certified Organisation
% of Normal
0 - 25
25 - 50
50 - 100
100 - 200
200 - 1,000

Australia Millenium drought





© Commonwealth of Australia 2015, Australian Bureau of Meteorology ID code: IGiMapAWAPDecilesNoncontiguous
Issued: 23/03/2015© Commonwealth of Australia 2011, Australian Bureau of Meteorology ID code: AWAP
Issued: 28/07/201

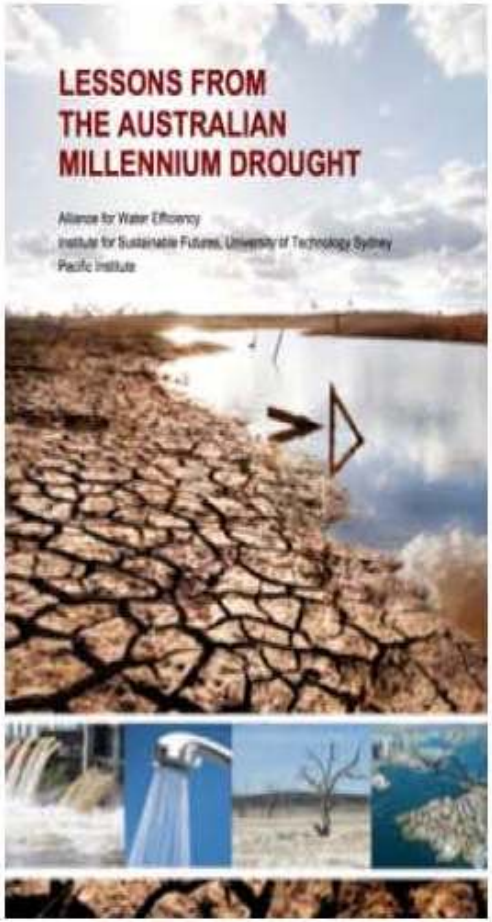
Environmental impacts

- Streamflows significantly reduced (some 5% of natural flow)
- Environmental flows restricted to provide for critical human needs
- Acidification of Lower Lakes
- Dying floodplain forests
- Multiple species at risk of extinction

UNIVERSITY OF CANBERRA

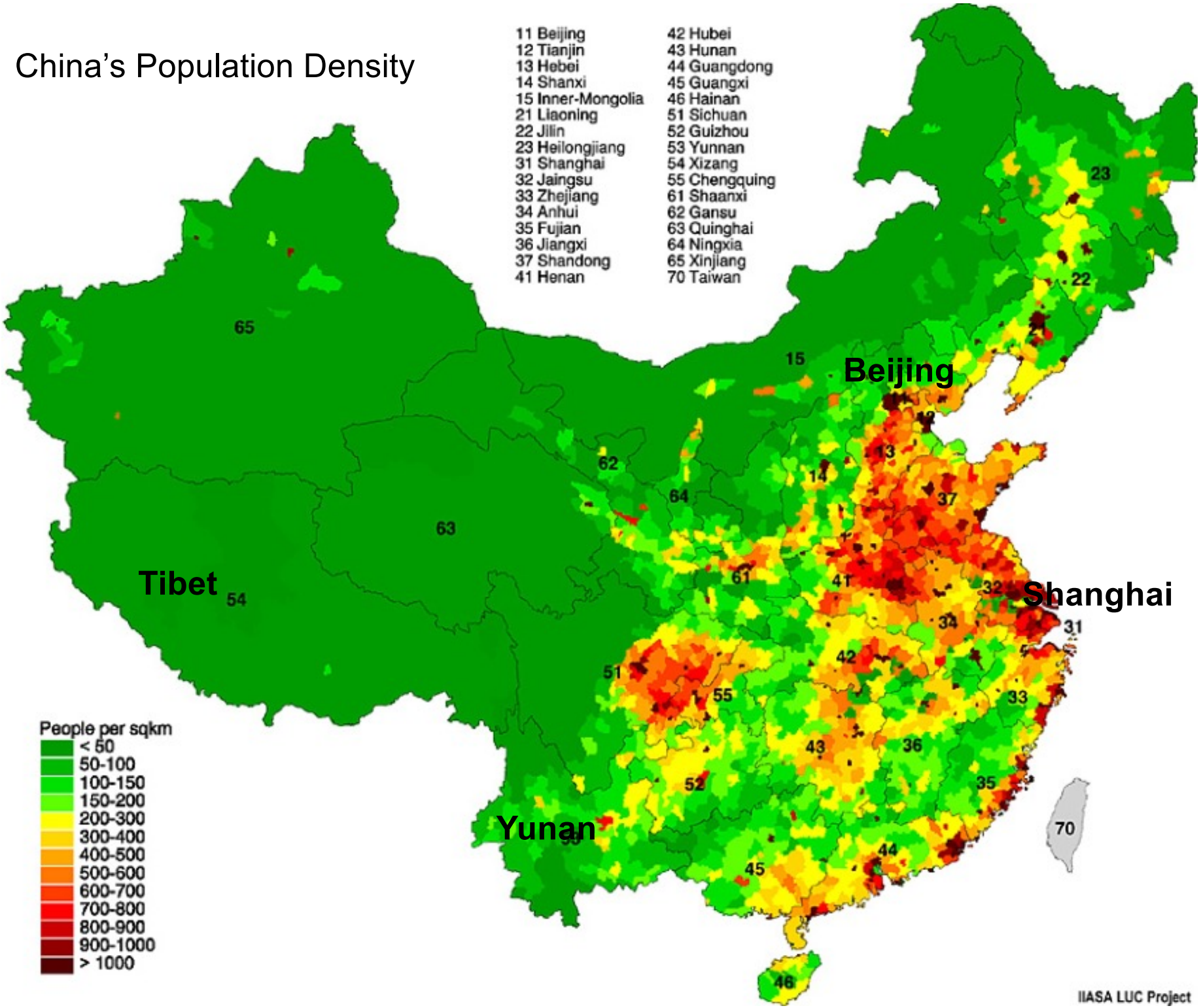
INSTITUTE FOR APPLIED ECOLOGY

Conclusions



- Integrating long term supply demand planning and drought response
- Demand-side options: cheapest, quickest and biggest
- Speaking and listening
- No-regrets options – future-proofing
- Data, monitoring and measurement

China's Population Density



Population
US – 312 million
China – 1.4 billion
(1.6 b)

Water Use / Person
US - 484,500 gal
China - 116,000 gal

Area Size Comparable
US - Dry SW, Wet N
China - Dry N, Wet S

Cindy Lin – Former USEPA Water

South to North Water Diversion Project

Beijing
Tianjin
Weihai
CENTRAL ROUTE
EASTERN ROUTE
WESTERN ROUTES
Danjiangkou
Reservoir
Jiangdu
Yellow River
Huai River
Huai River
Yangtze River
Yellow River

circle of blue

China.org.cn

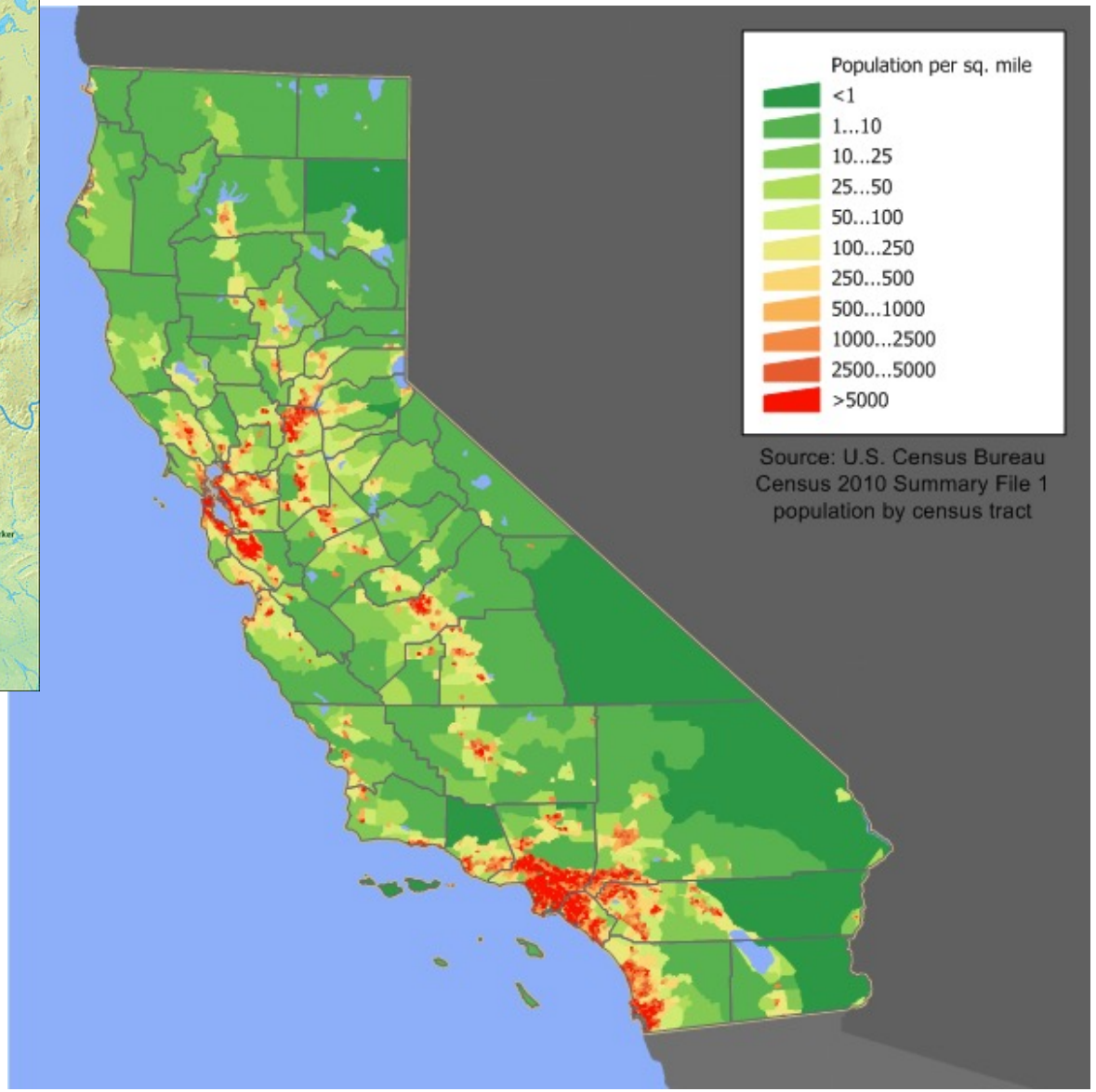
Part 4

March of the desert

A shepherd leads his flock across a dried-up river bed in northern China's Shanxi province

AFP file

Population vs. water supply…



Are we in a drought right now?

A. Yes!

B. No way!

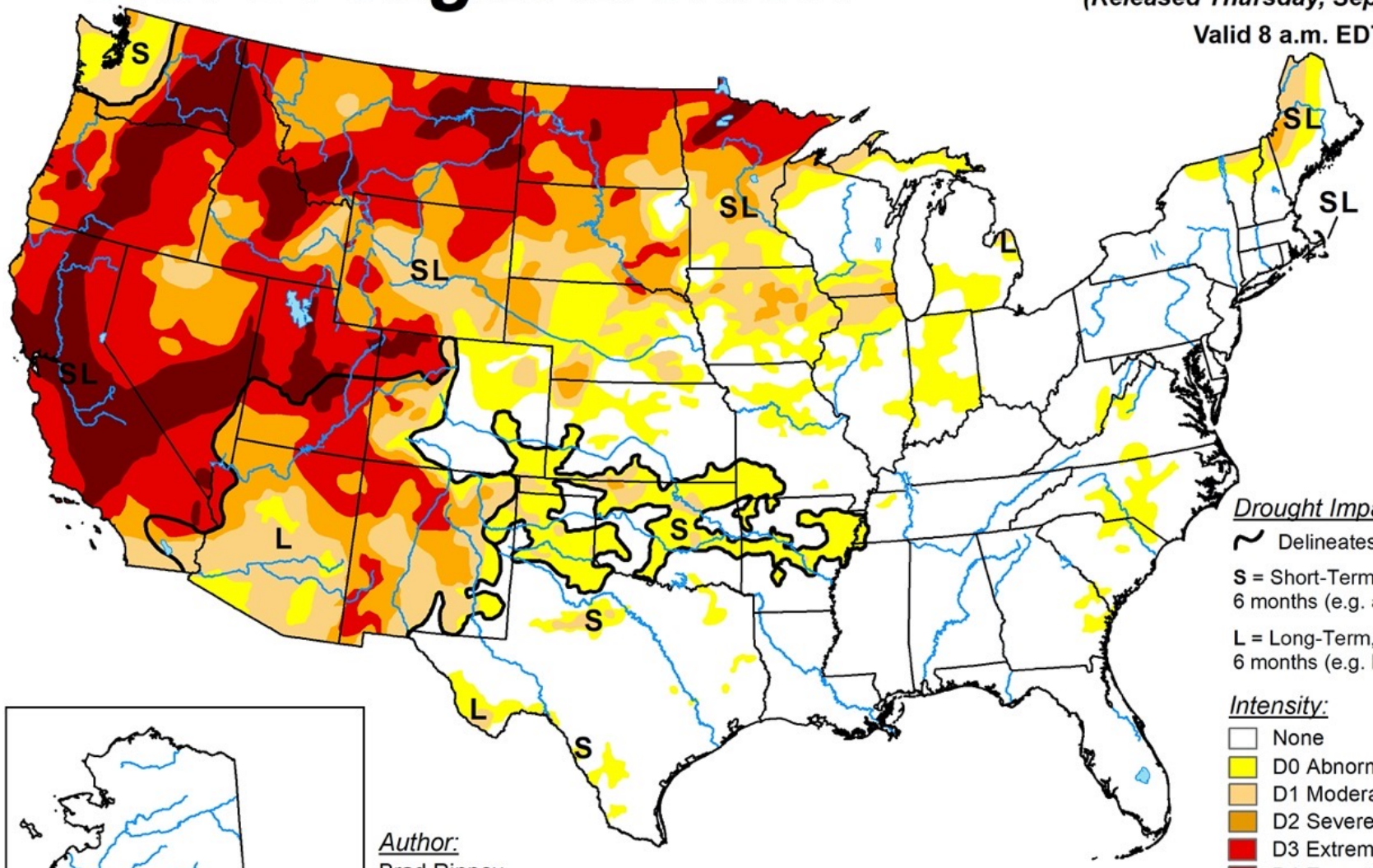
C. ….maybe?

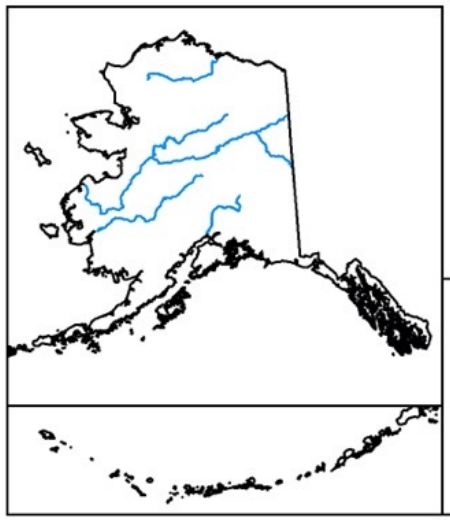
U.S. Drought Monitor

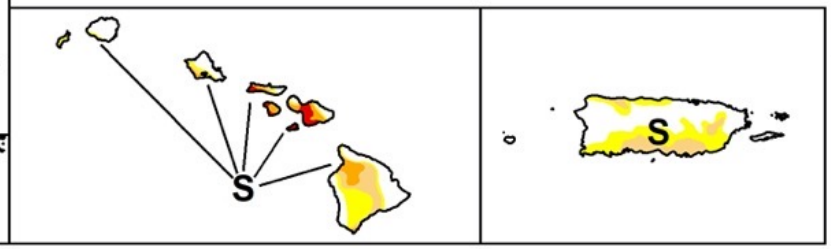
September 14, 2021

(Released Thursday, Sep. 16, 2021)

Valid 8 a.m. EDT







Drought Impact Types:

Delineates dominant impacts

S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)

L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

Author:

Brad Rippey

U.S. Department of Agriculture

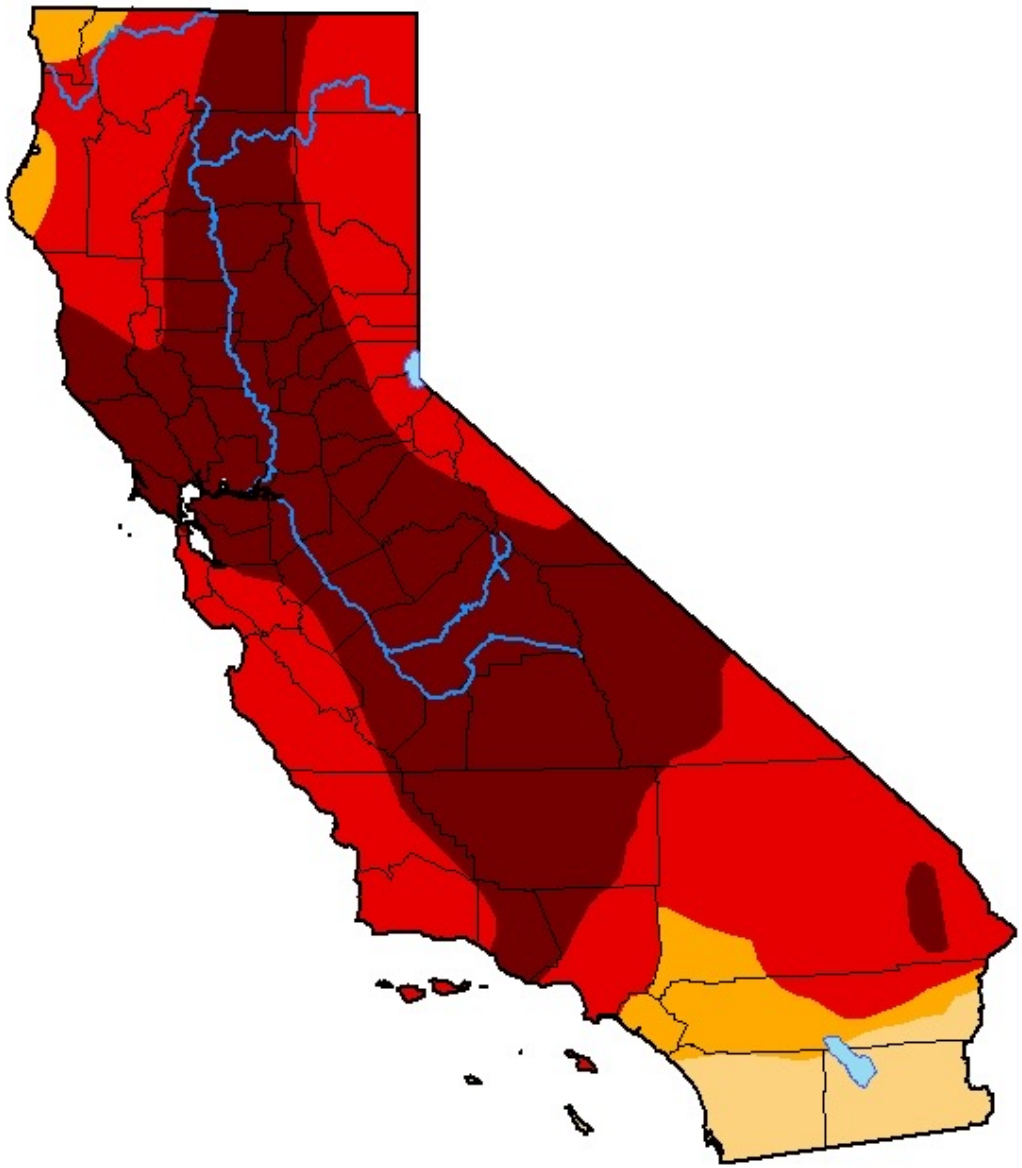
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

USDA NDMC DEPARTMENT OF COMMERCE NOAA

droughtmonitor.unl.edu

U.S. Drought Monitor

California



September 14, 2021

(Released Thursday, Sep. 16, 2021)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	93.93	87.94	45.66
Last Week *09-07-2021*	0.00	100.00	100.00	93.93	87.94	45.66
3 Months Ago *06-15-2021*	0.00	100.00	100.00	94.75	85.44	33.32
Start of Calendar Year *12-29-2020*	0.00	100.00	95.17	74.34	33.75	1.19
Start of Water Year *09-29-2020*	15.35	84.65	67.65	35.62	12.74	0.00
One Year Ago *09-15-2020*	15.62	84.38	67.09	35.26	3.17	0.00

Intensity:

- None
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

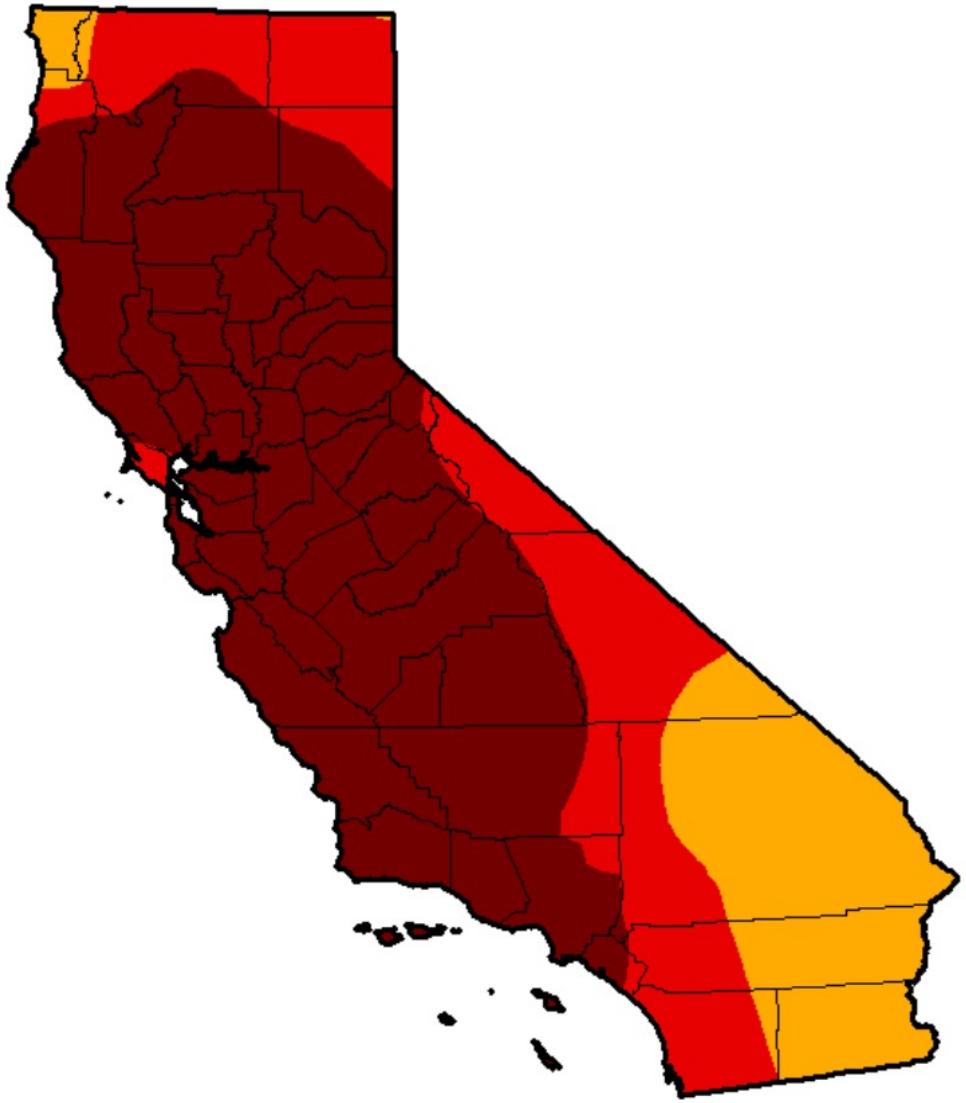
Author:

Brad Rippey

U.S. Department of Agriculture

droughtmonitor.unl.edu

U.S. Drought Monitor
California



July 29, 2014

(Released Thursday, Jul. 31, 2014)

Valid 8 a.m. EDT

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	100.00	81.89	58.41
Last Week 7/22/2014	0.00	100.00	100.00	100.00	81.89	36.49
3 Months Ago 4/29/2014	0.00	100.00	100.00	96.01	76.68	24.77
Start of Calendar Year 12/31/2013	2.61	97.39	94.25	87.53	27.59	0.00
Start of Water Year 10/1/2013	2.63	97.37	95.95	84.12	11.36	0.00
One Year Ago 7/30/2013	0.00	100.00	98.23	93.86	0.00	0.00

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Brad Rippey
U.S. Department of Agriculture

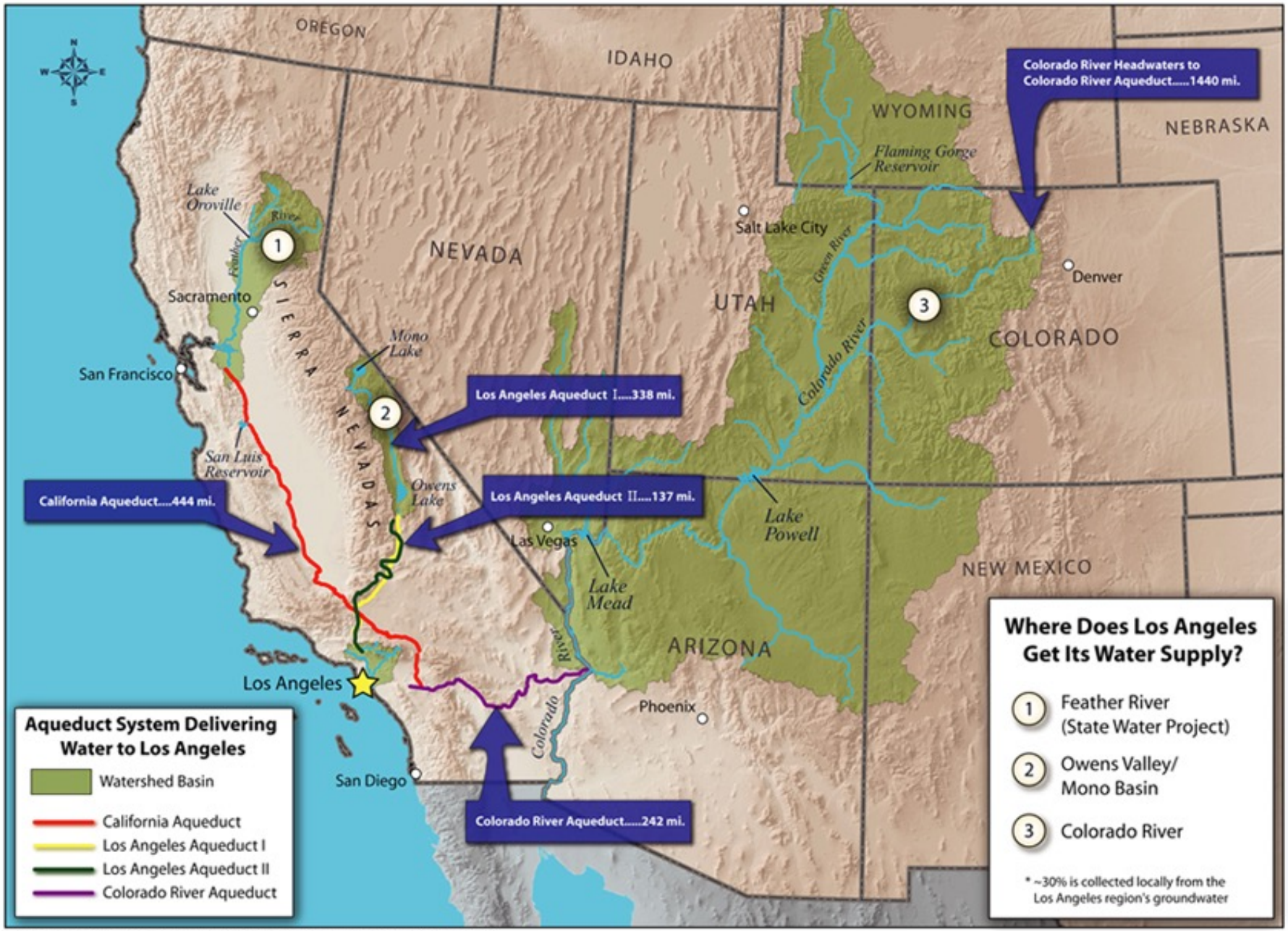
http://droughtmonitor.unl.edu/

Camp Fire, Butte County, California, USA
November 8th, 2018 - Natural colors with IR highlights

Landsat 8 data courtesy of the U.S. Geological Survey
Processed by Pierre Markuse

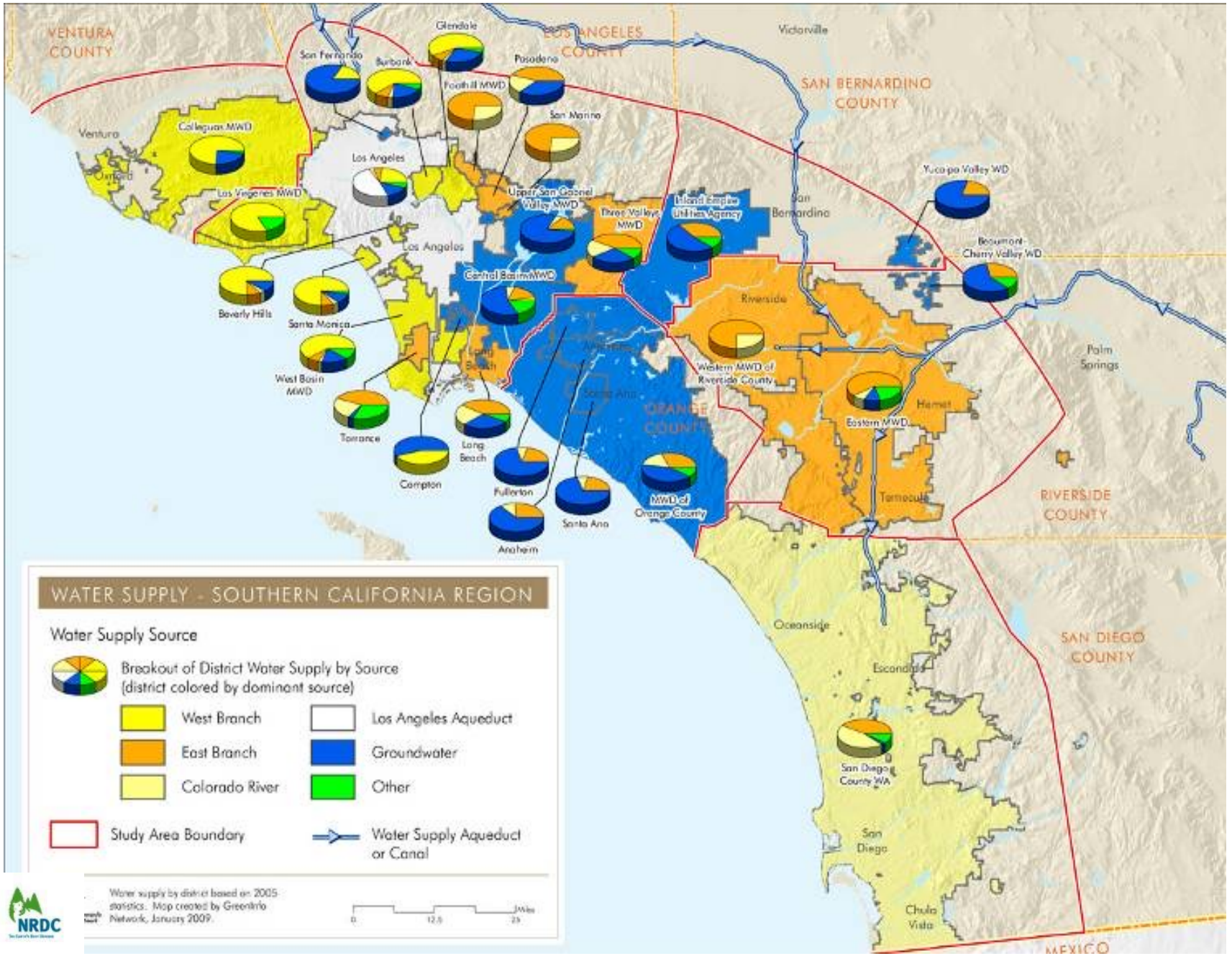
Where does Southern California get its Water?

Department of Water Resources

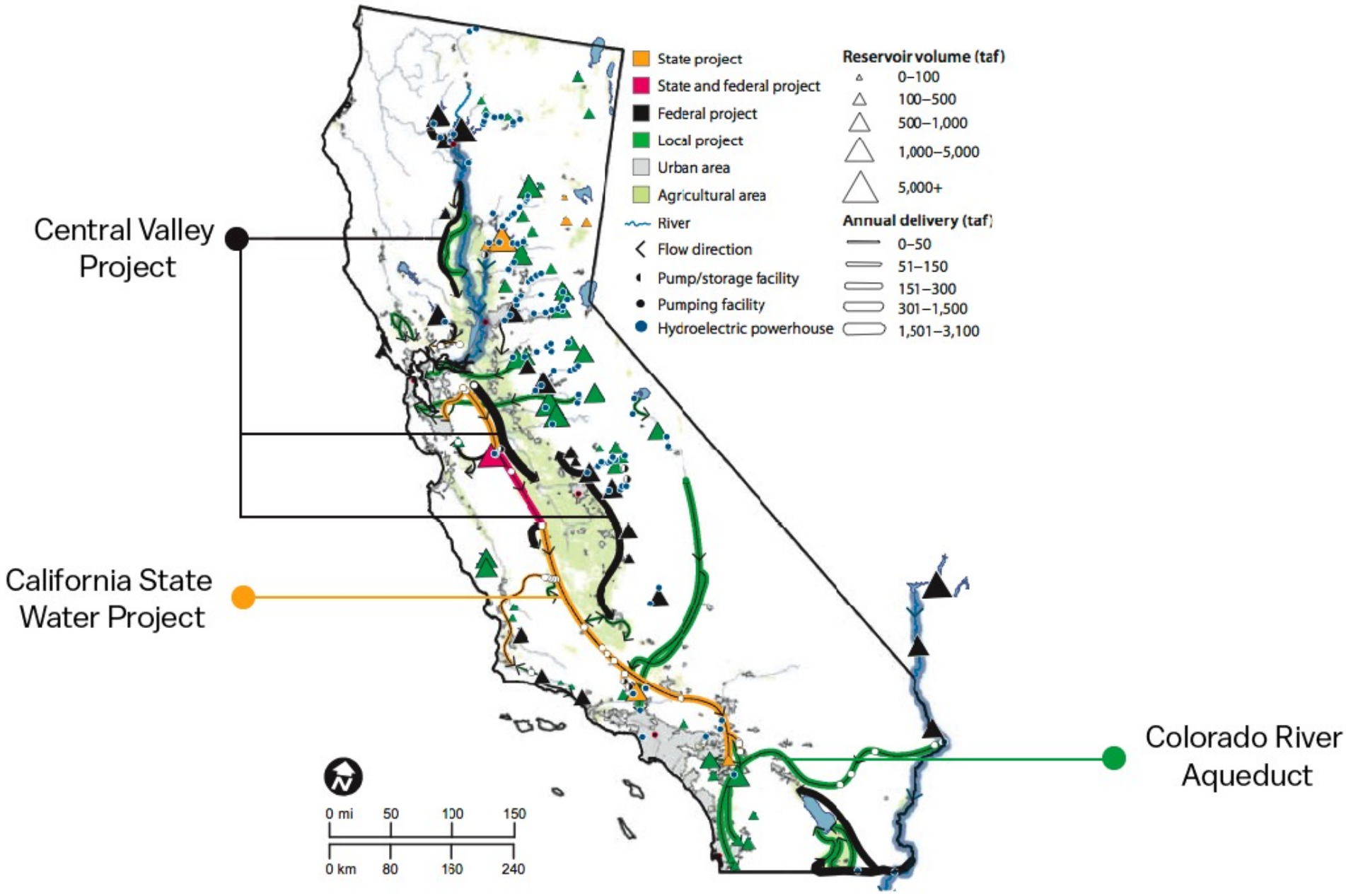


This map was created by the Los Angeles & San Gabriel Rivers Watershed Council, 2003 ©

Southern California Sources of Water



California has an elaborate network of conveyance and storage infrastructure, controlled by different agencies



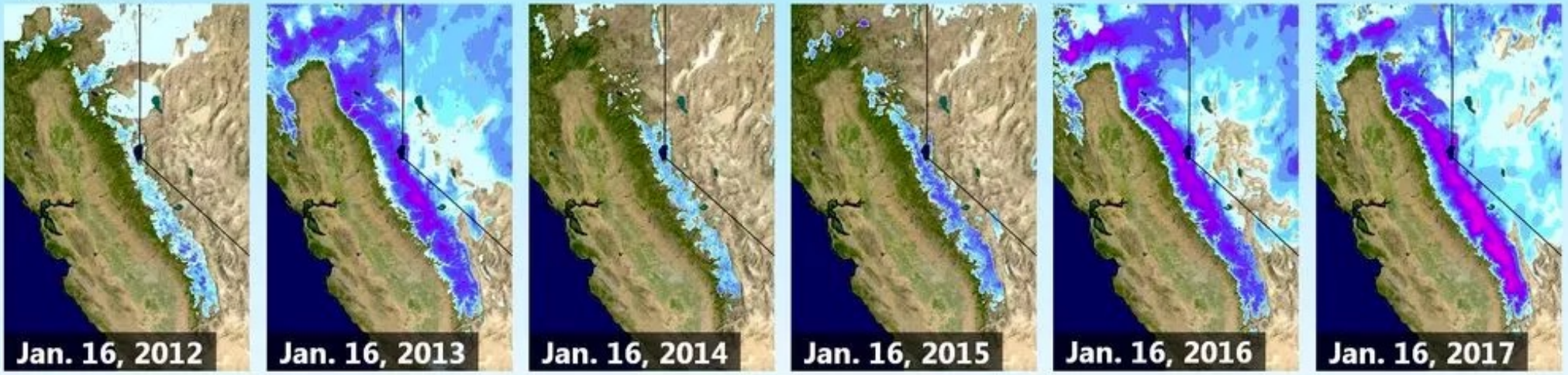
April 2010 – Snowpack measurement

April 2015 – Snowpack measurement

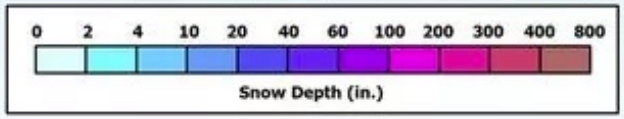
April 2016 – Snowpack measurement

Sierra Snowpack Through The Drought

2012-2017

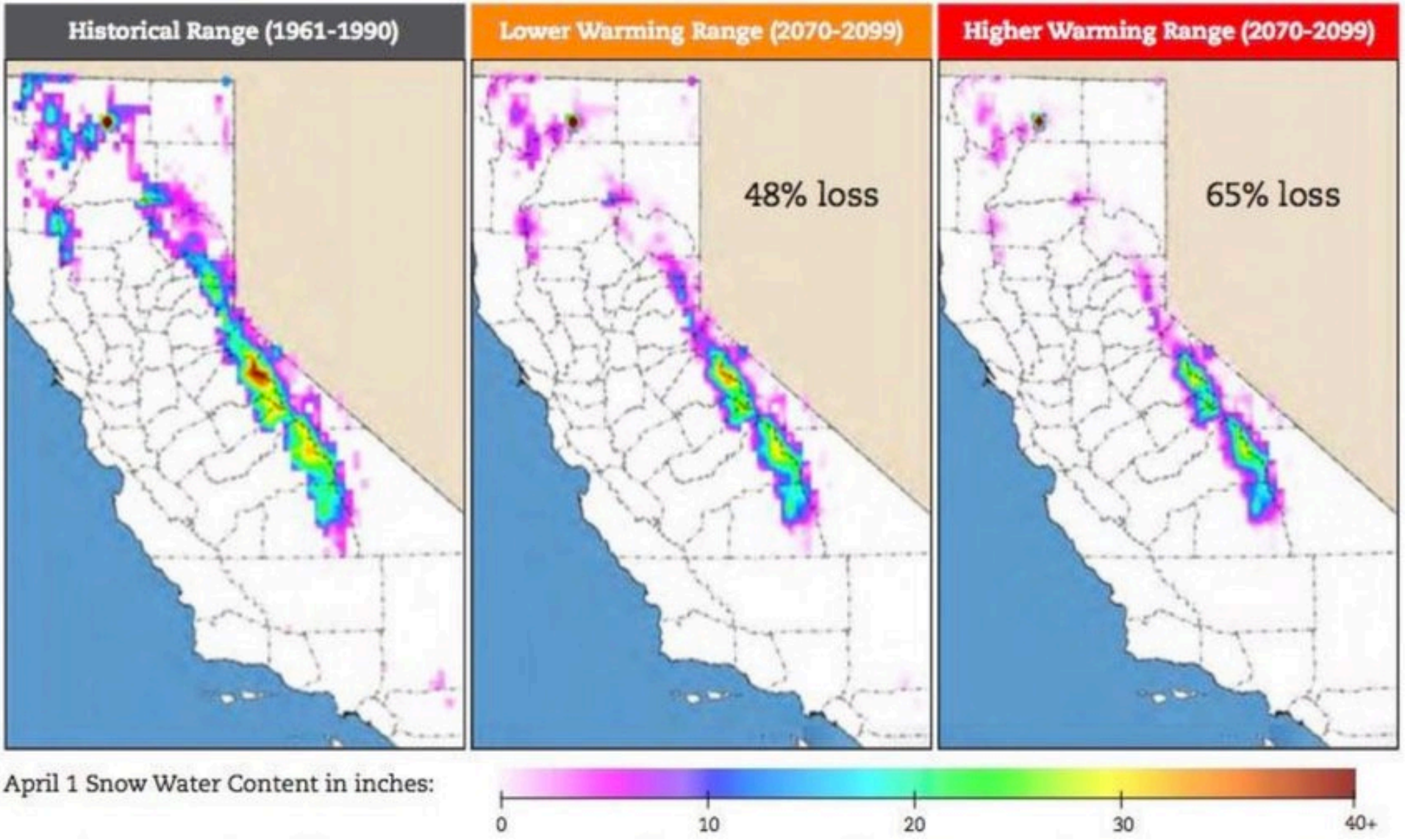


Issued: January 16, 2017



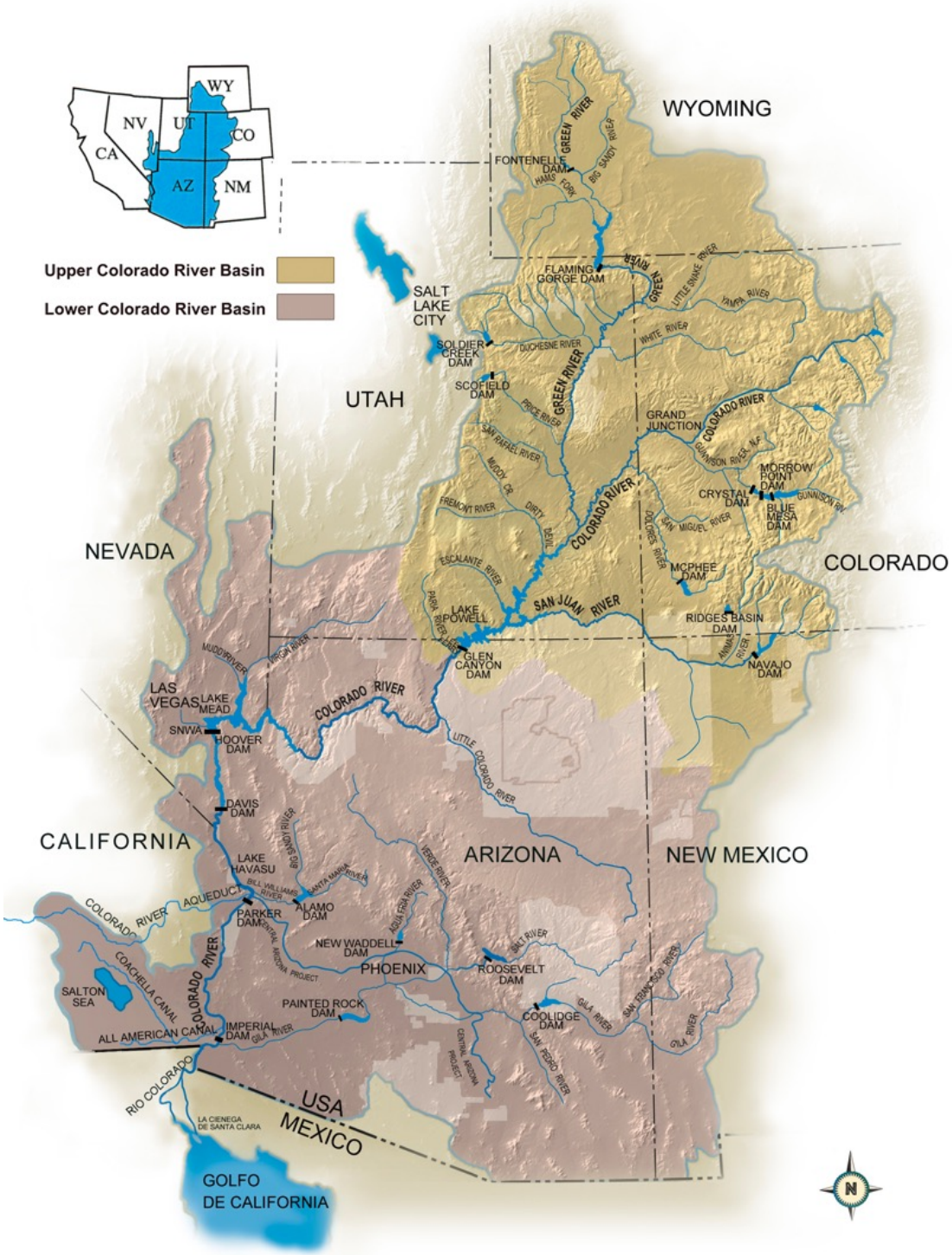
January 2018 – Snowpack measurement

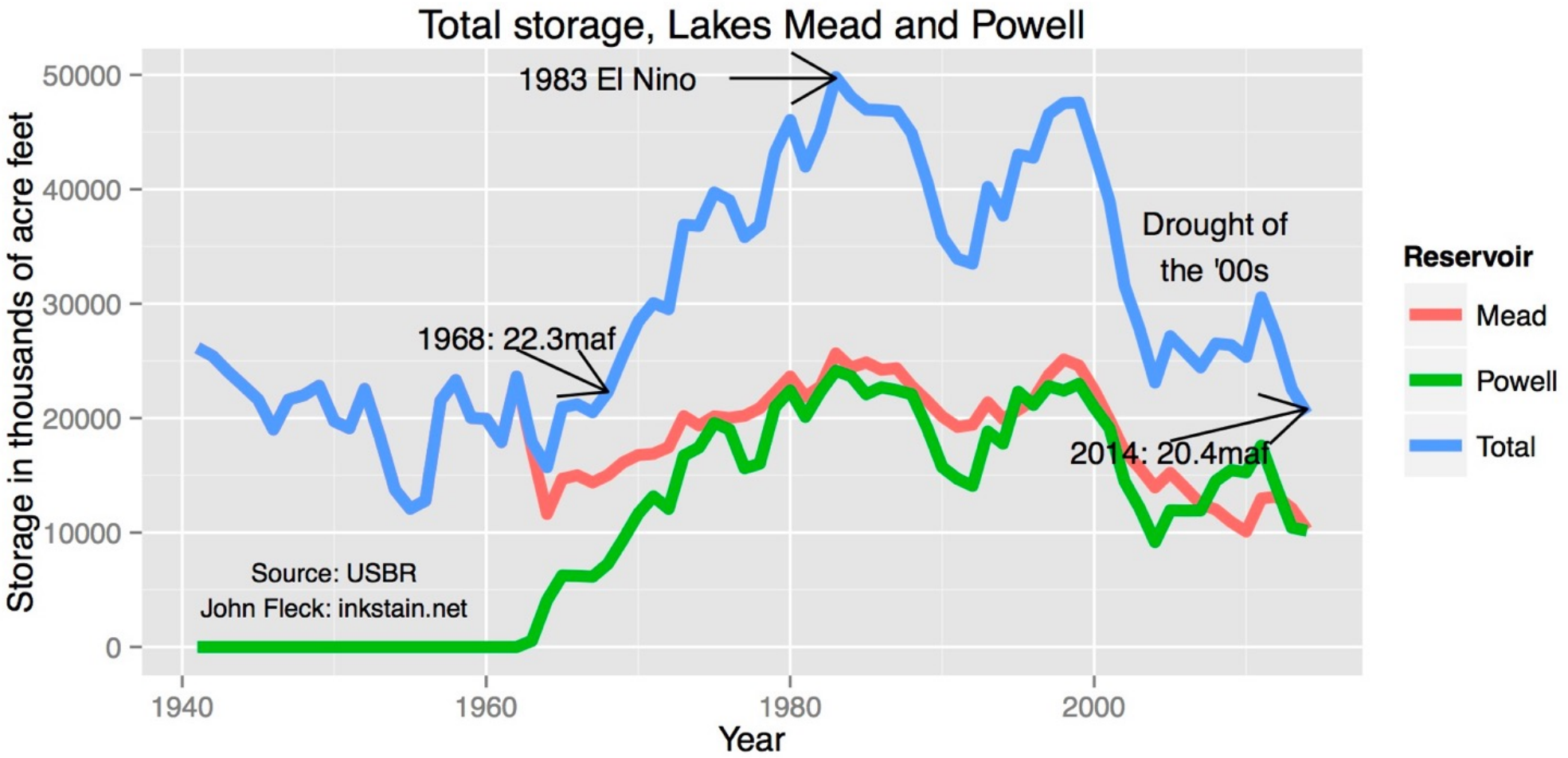
Historical and Projected California Snowpack



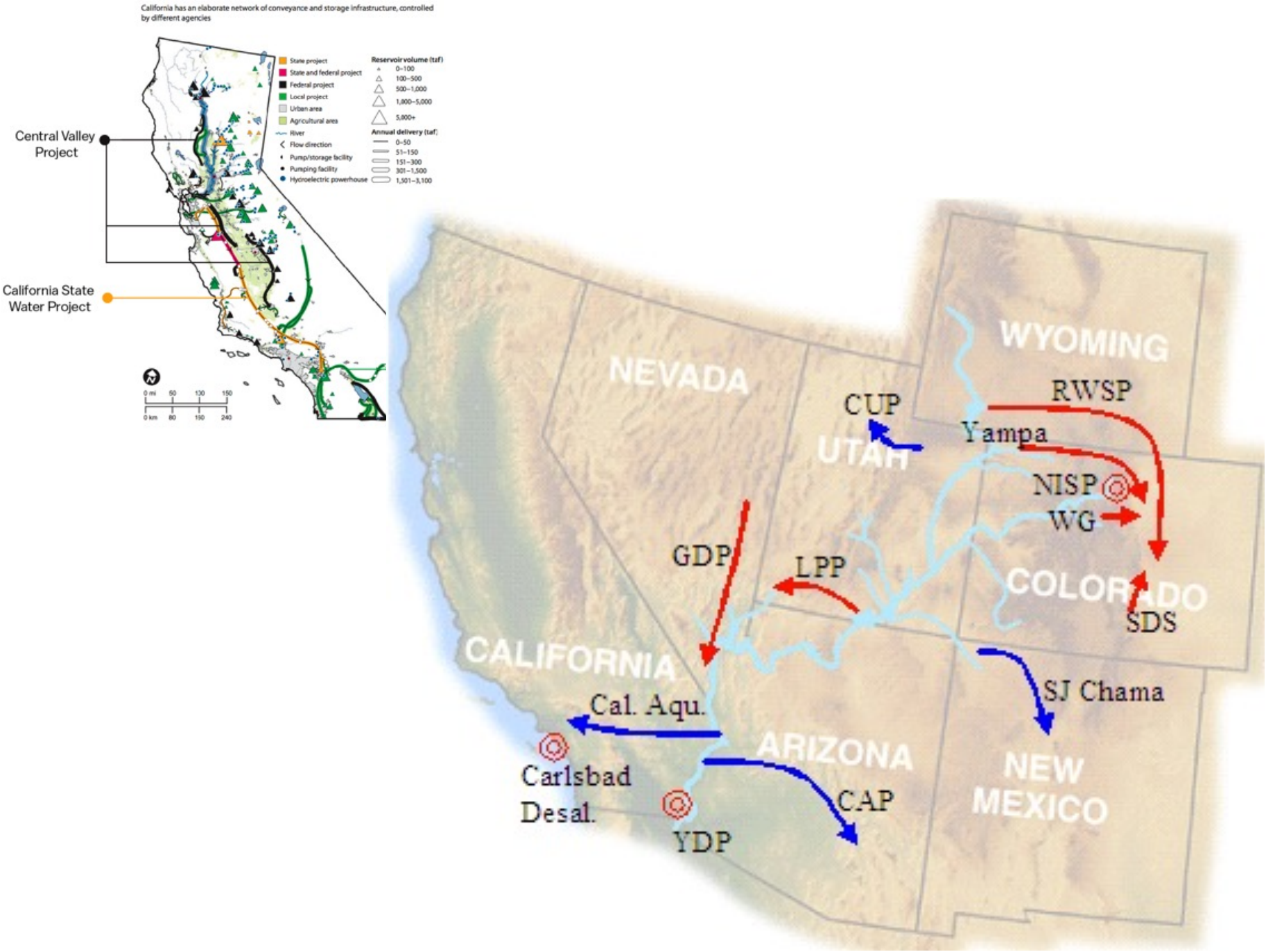
California Department of Water Resources

Lake Mead – Colorado River

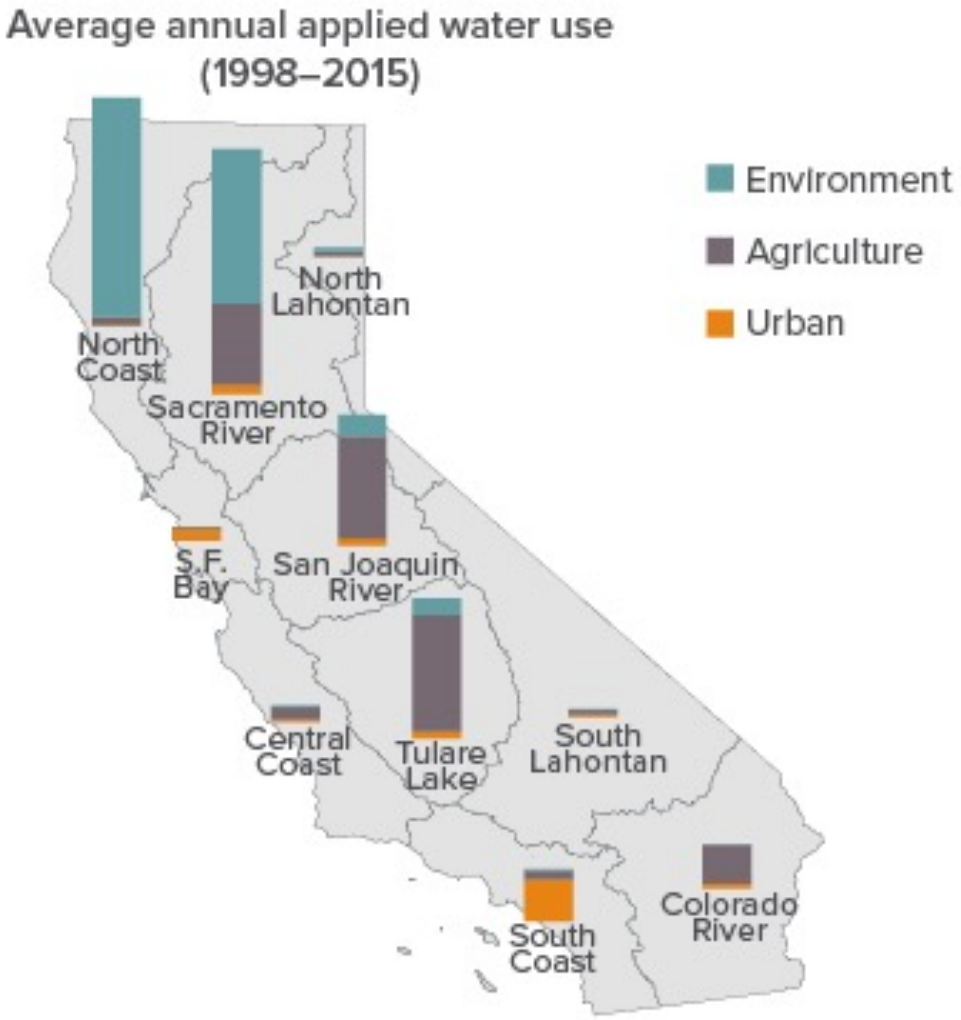

WY
NV
UT
CO
CA
AZ
NM
Upper Colorado River Basin
Lower Colorado River Basin
WYOMING
UTAH
NEVADA
COLORADO
CALIFORNIA
ARIZONA
NEW MEXICO
USA
MEXICO
SALT LAKE CITY
LAS VEGAS
PHOENIX
GOLFO DE CALIFORNIA
FONTENELLE DAM
FLAMING GORGE DAM
SOLDIER CREEK DAM
SCOFIELD DAM
GRAND JUNCTION
MORROW POINT DAM
CRYSTAL DAM
BLUE MESA DAM
MCPHEE DAM
RIDGES BASIN DAM
NAVAJO DAM
LAKE POWELL
GLEN CANYON DAM
LAKE MEAD
HOOVER DAM
SNWA
DAVIS DAM
LAKE HAVASU
PARKER DAM
ALAMO DAM
NEW WADDELL DAM
ROOSEVELT DAM
COOLIDGE DAM
PAINTED ROCK DAM
IMPERIAL DAM
SALTON SEA
GREEN RIVER
COLORADO RIVER
SAN JUAN RIVER
LITTLE COLORADO RIVER
GILA RIVER
BIG SANDY RIVER
HAMS FORK
LITTLE SNAKE RIVER
YAMPA RIVER
WHITE RIVER
DUCHESNE RIVER
PRICE RIVER
SAN RAFAEL RIVER
MUDDY CR.
FREMONT RIVER
DIRTY DEVIL
ESCALANTE RIVER
PARIA RIVER
LITTLE
GUNNISON RIVER, NF
GUNNISON RIV.
SAN MIGUEL RIVER
DOLORES RIVER
ANIMAS RIVER
MUDDY RIVER
VIRGIN RIVER
BILL WILLIAMS RIVER
BIG SANDY RIVER
SANTA MARIA RIVER
AQUEDUCT
CENTRAL ARIZONA PROJECT
AGUA FRIA RIVER
VERDE RIVER
SALT RIVER
SAN FRANCISCO RIVER
COACHELLA CANAL
ALL AMERICAN CANAL
RIO COLORADO
LA CIENEGA DE SANTA CLARA
SAN PEDRO RIVER
CENTRAL ARIZONA PROJECT
N

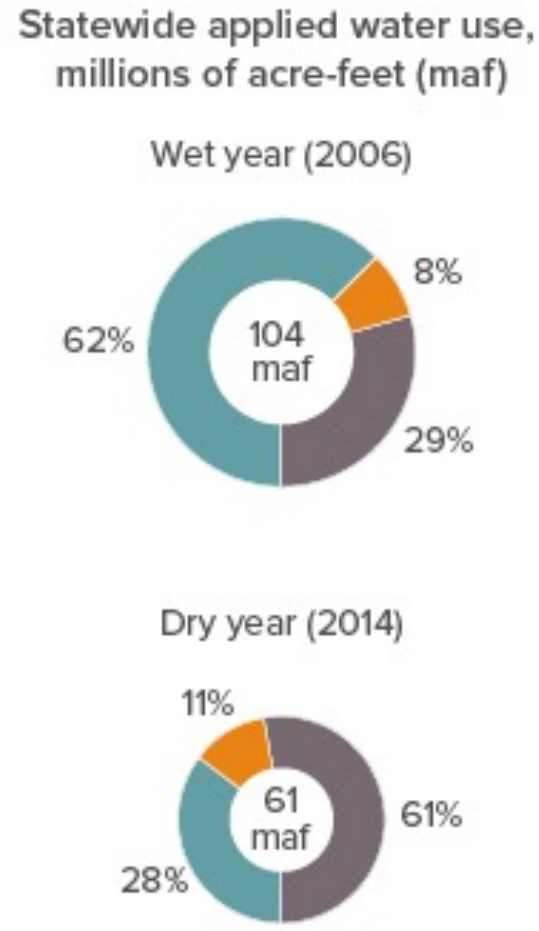

Total storage, Lakes Mead and Powell
1983 El Nino
Drought of the '00s
1968: 22.3maf
2014: 20.4maf
Source: USBR
John Fleck: inkstain.net
Storage in thousands of acre feet
50000
40000
30000
20000
10000
0
1940
1960
1980
2000
Year
Reservoir
Mead
Powell
Total

Colorado River Delta


California has an elaborate network of conveyance and storage infrastructure, controlled by different agencies
Central Valley Project
California State Water Project
State project
State and federal project
Federal project
Local project
Urban area
Agricultural area
River
Flow direction
Pump/storage facility
Pumping facility
Hycroelectric powerhouse
Reservoir volume (taf)
0–100
100–500
500–1,000
1,000–5,000
5,000+
Annual delivery (taf)
0–50
51–150
151–300
301–1,500
1,501–3,100
0 mi 50 100 150
0 km 80 150 240
WYOMING
NEVADA
UTAH
CUP
RWSP
Yampa
NISP
WG
GDP
LPP
COLORADO
SDS
CALIFORNIA
SJ Chama
Cal. Aqu.
ARIZONA
NEW MEXICO
Carlsbad Desal.
YDP
CAP

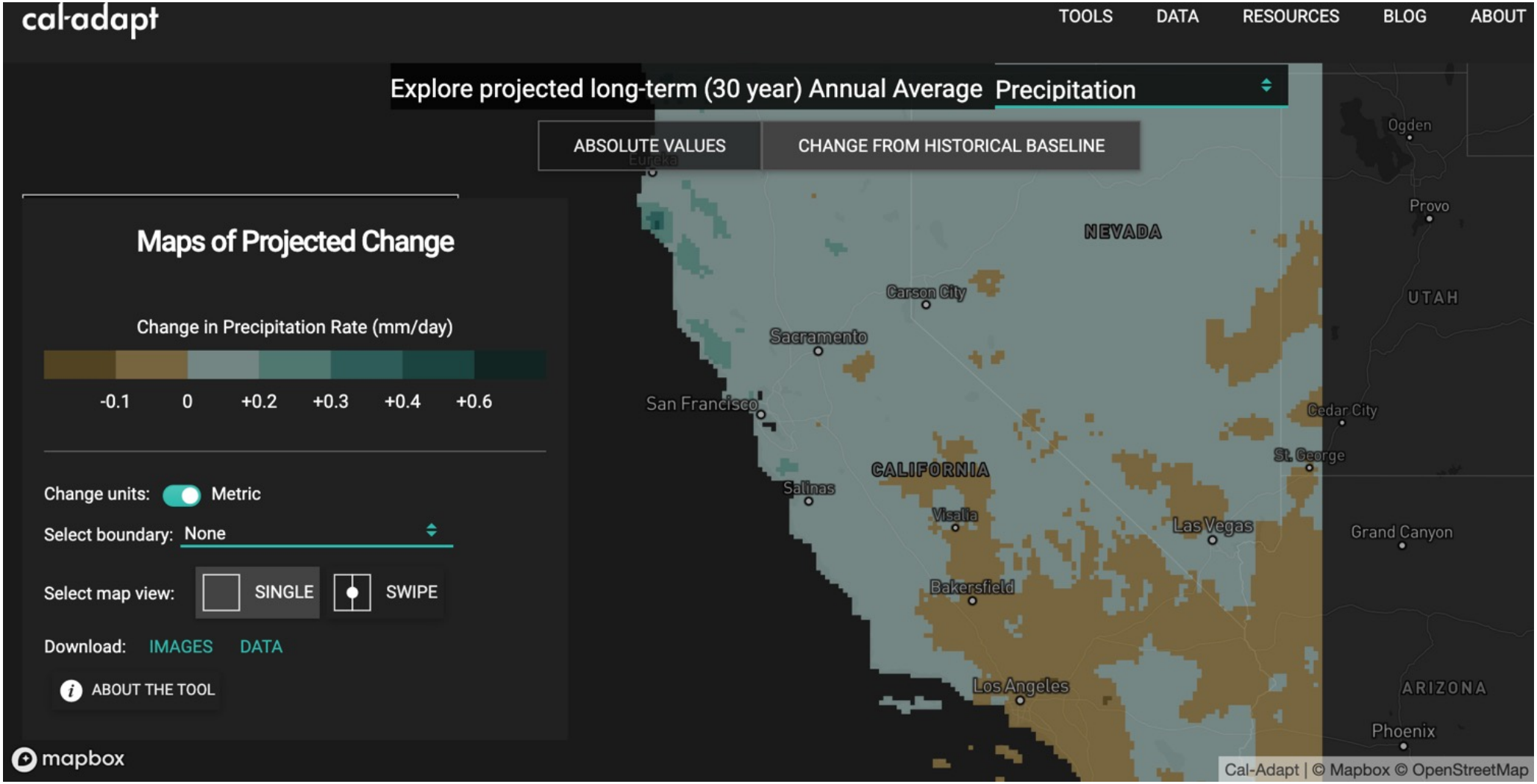
California's water use varies dramatically across regions and between wet and dry years



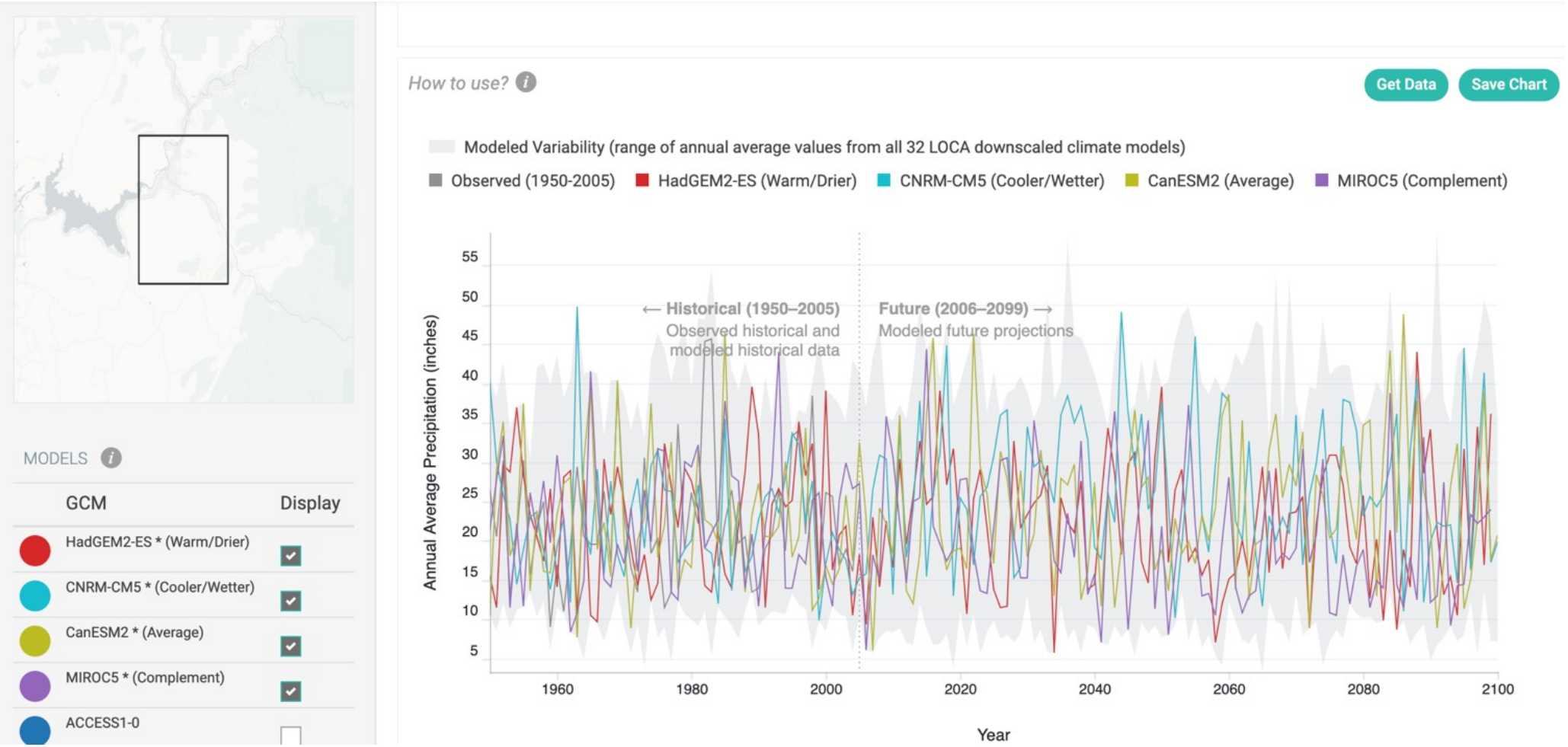


PPIC

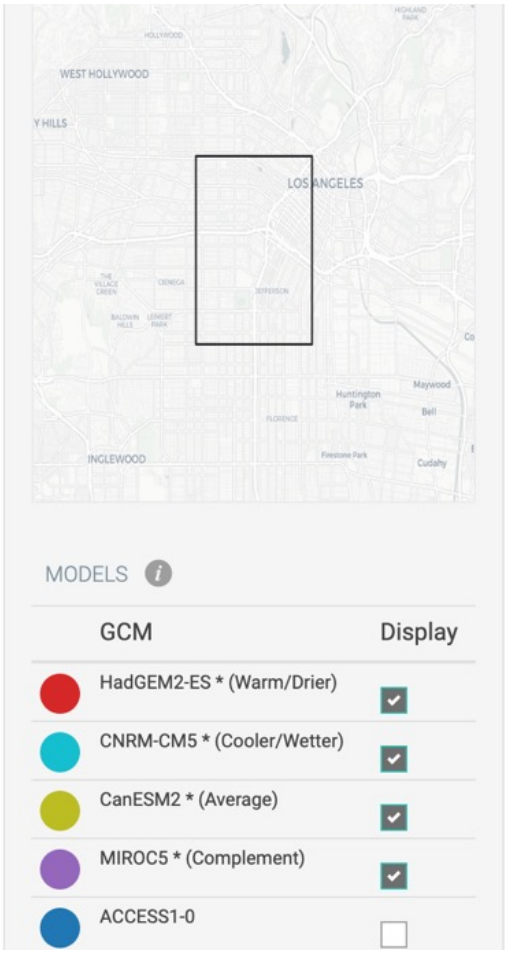
Climate Change – Volume *and* Timing

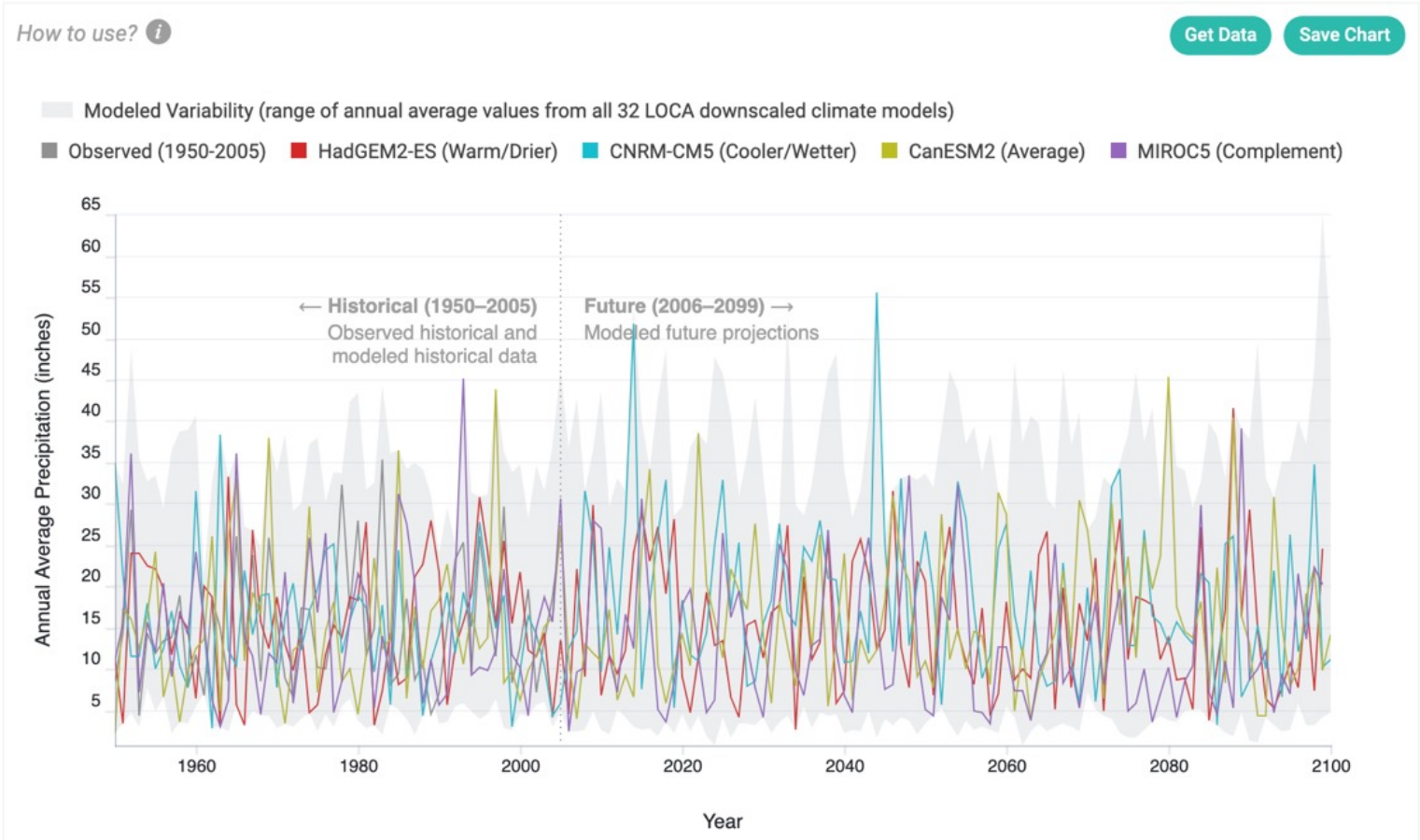


Precipitation – Three Rivers, CA

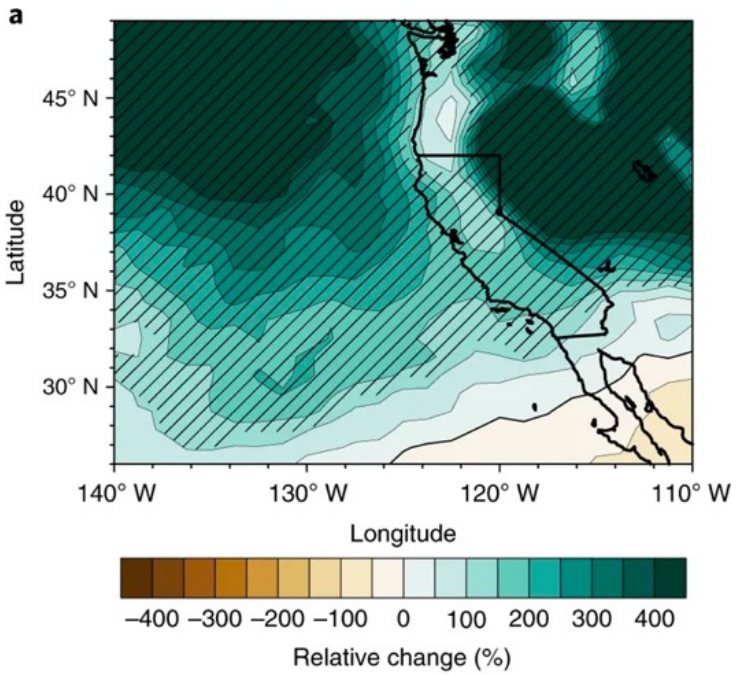


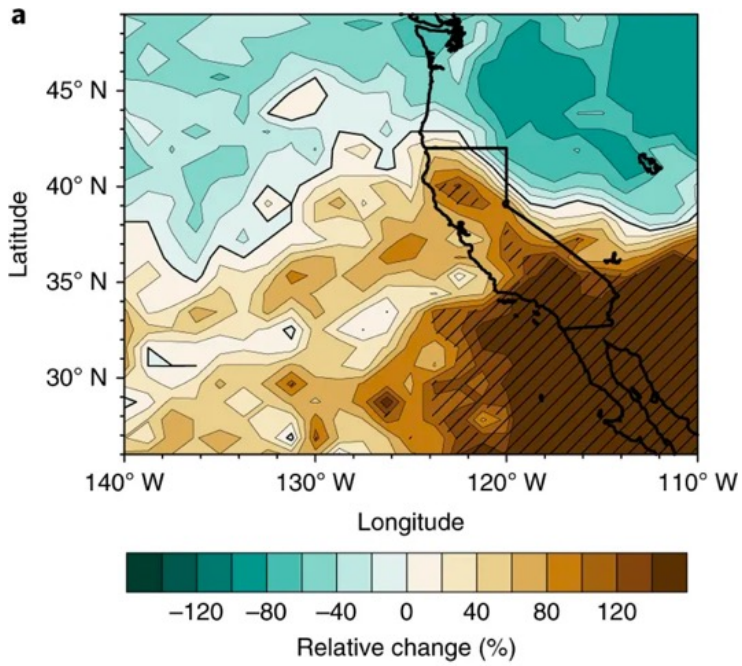
Precipitation – Los Angeles

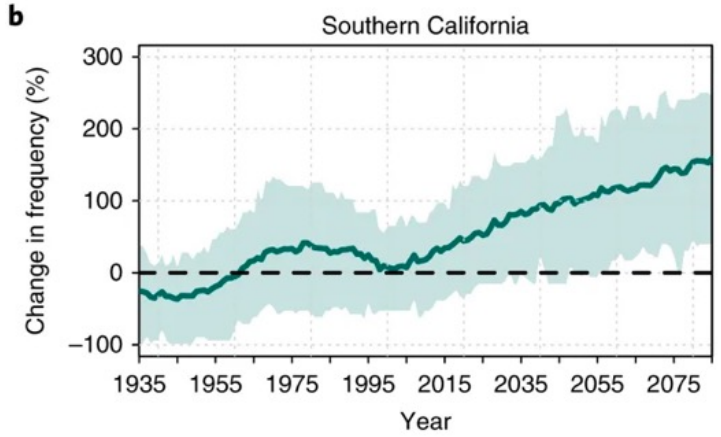


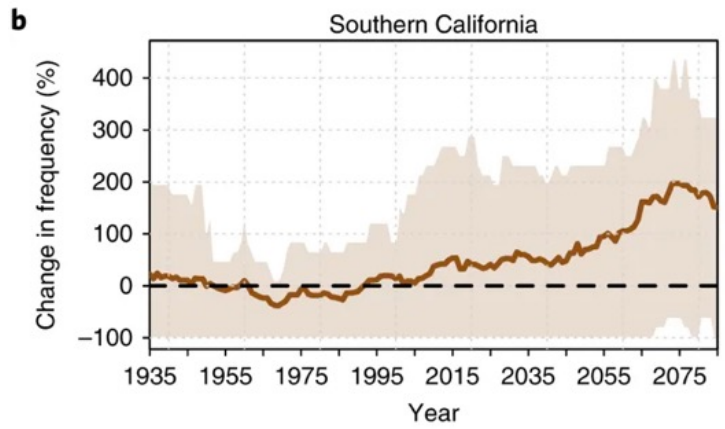


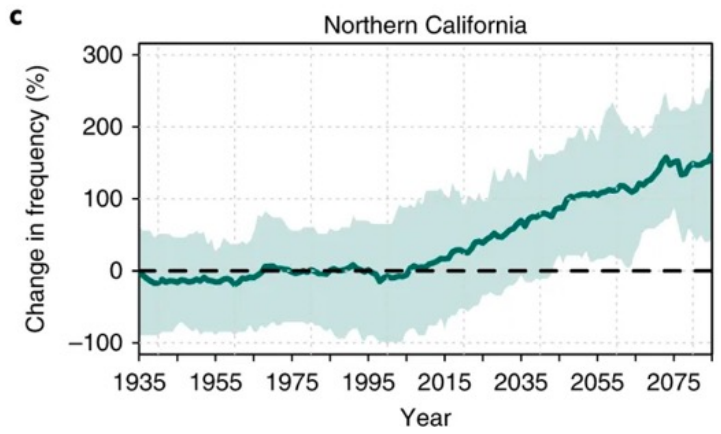
Change in frequency of extremely wet / dry seasons – coupled with an increase in extreme weather events overall

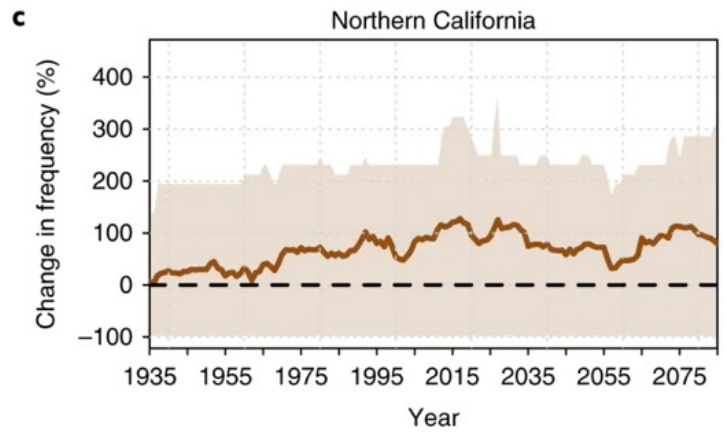




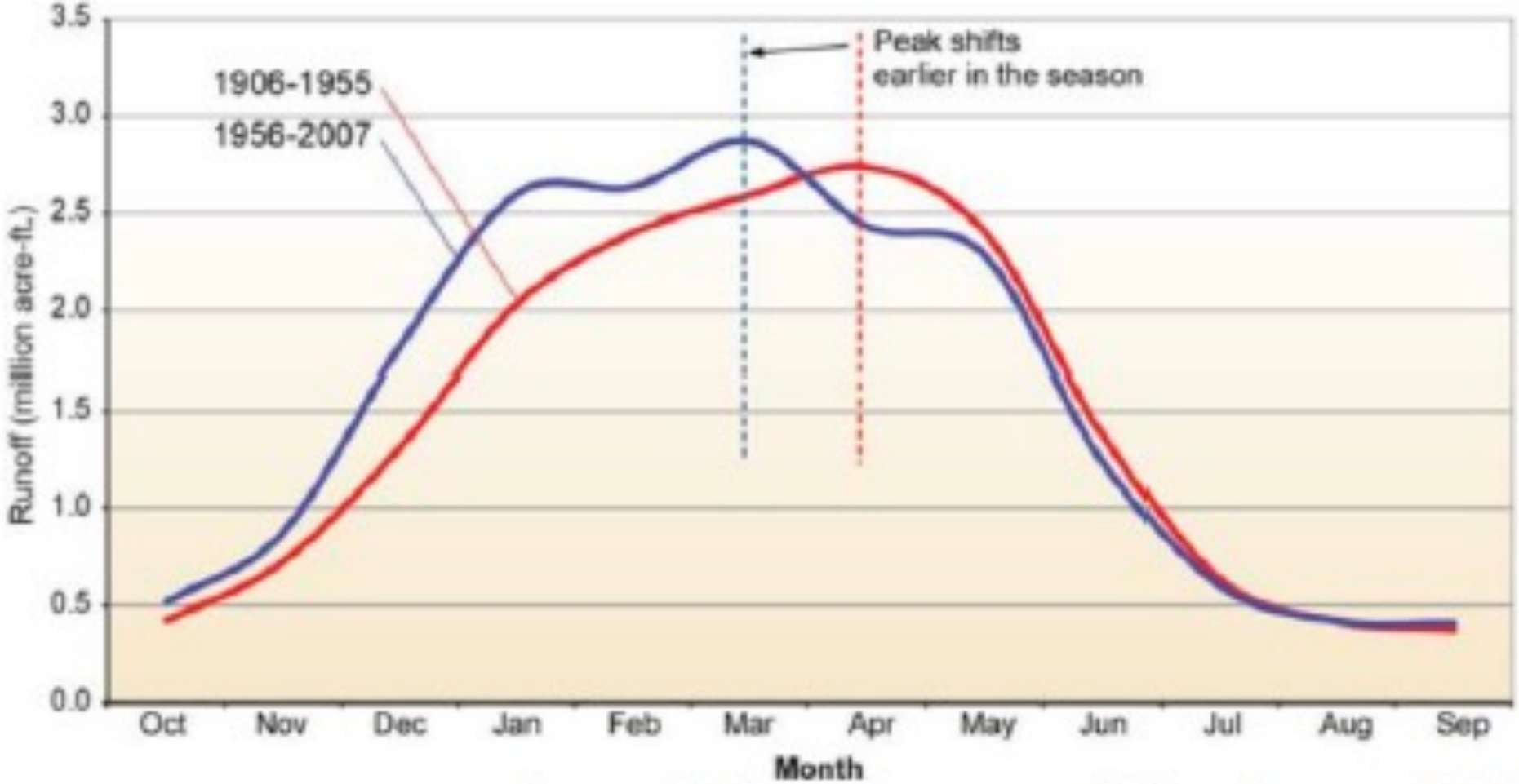




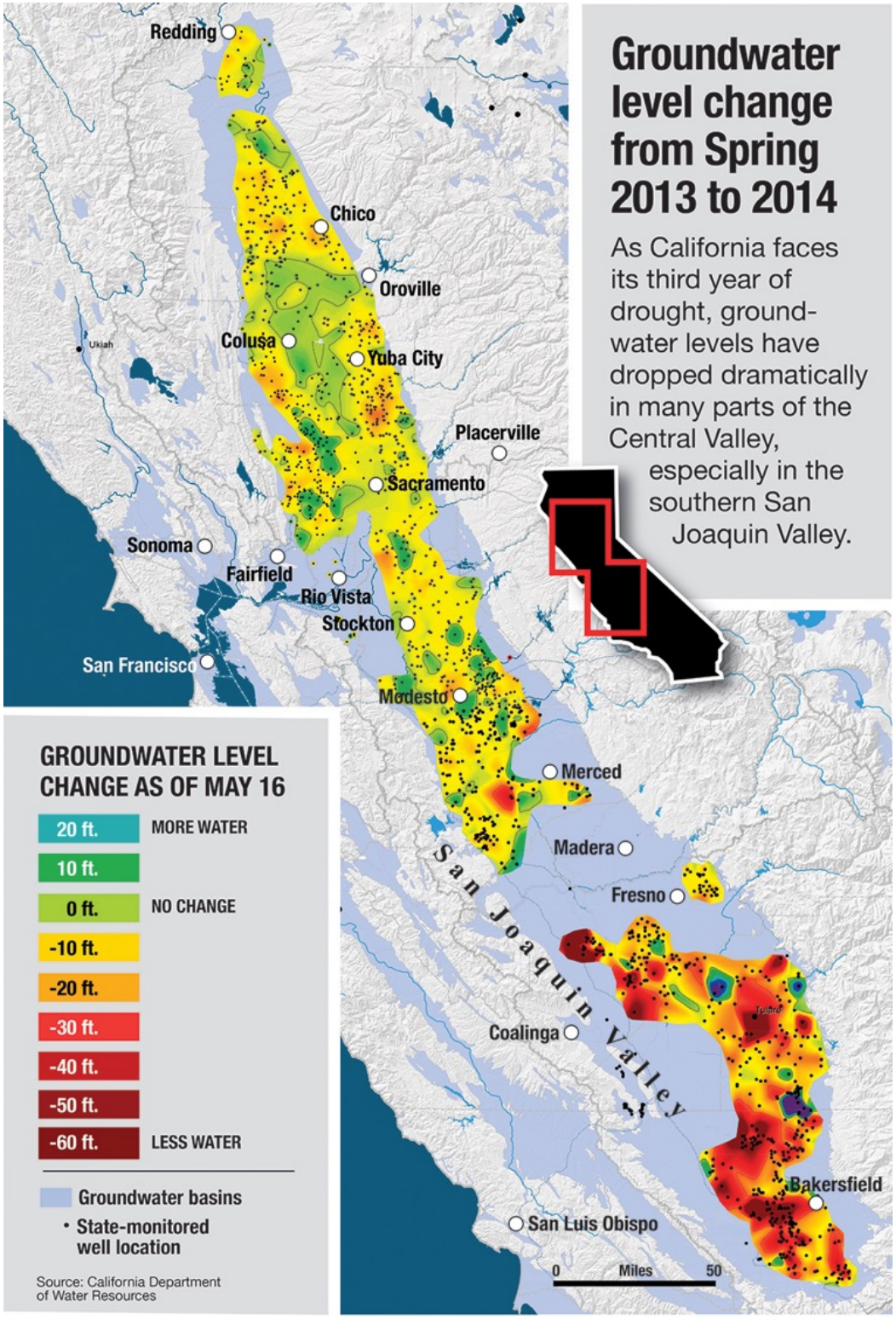




Monthly average runoff, Sacramento River System



Source: California Department of Water Resources 2017


Groundwater level change from Spring 2013 to 2014
As California faces its third year of drought, groundwater levels have dropped dramatically in many parts of the Central Valley, especially in the southern San Joaquin Valley.
Redding
Chico
Oroville
Colusa
Yuba City
Ukiah
Placerville
Sacramento
Sonoma
Fairfield
Rio Vista
Stockton
San Francisco
Modesto
Merced
Madera
Fresno
San Joaquin Valley
Coalinga
Bakersfield
San Luis Obispo
0 Miles 50
GROUNDWATER LEVEL CHANGE AS OF MAY 16
20 ft. MORE WATER
10 ft.
0 ft. NO CHANGE
-10 ft.
-20 ft.
-30 ft.
-40 ft.
-50 ft.
-60 ft. LESS WATER
Groundwater basins
State-monitored well location
Source: California Department of Water Resources

Salton Sea

Mono Lake

Runoff and Pollution

Environmental Justice